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The Geographical Journal

Vol. LXVIII No. 5 November 1926

DARWIN'S CHILE

Dr. Frank M. Chapman, American Museum of Natural History

Read at the Meeting of the Society, 31 May 1926.

JUST one hundred years ago the *Adventure*, under Captain King, began a survey of Patagonia and Tierra del Fuego. Five years later, in continuation of this work, the *Beagle*, under Captain Fitzroy, set sail on a voyage which yielded results far beyond the reckoning of the Admiralty.

Of the nearly five years occupied by this voyage (27 December 1831 to 2 October 1836) slightly over three and a third were passed in South American waters, and of this time about two and a half years were devoted to Chile. It is natural, therefore, that we should think of the 'Journal' of the *Beagle's* naturalist as relating largely to South America, and in the main to Chile. Indeed, one-third of this classic volume is devoted to a record of observations in that country.

The opening paragraph of 'The Origin of Species' warrants the conclusion that the theories embodied in that epoch-making work had their inception in Darwin's experiences in South America. It reads: "When on board H.M.S. *Beagle* as naturalist, I was much struck with certain facts in the distribution of the inhabitants of South America, and in the geological relations of the present to the past inhabitants of that continent. These facts seemed to me to throw some light on the origin of species."

This statement expresses in a few words the thesis which, as an ornithologist and zoogeographer, I have attempted to develop during the past fifteen years. Before, therefore, we proceed with our narrative of travel in Chile, I beg you will permit me briefly to outline the nature of the studies which have led me to make three visits to that country.

In describing his passage of the Cordillera, Darwin comments on the comparatively recent age of the Andes, which we now know date from the latter part of the Tertiary. It seems evident, therefore, that when these mountains attained their full elevation the continent of South America had essentially its present outline; and, if we except possible disconnections in Central America, had practically the existing

relations to other continental areas. It is also probable that by the time the Andes were high enough to support zonal faunas, the life (I refer especially to the bird-life) of South America—at least in its major aspects—did not differ materially from that which is found there to-day. Hence it follows that not only can we give to the Andes a geological birthday, but we can form a fairly exact conception of the character of the avifauna from which has been evolved the hundreds of species of birds now confined to their upper life-zones.

In a word, we may look upon the Andes as a New World which has been annexed to our world at a known time, and which has received its fauna and flora from sources and under conditions which, if not clearly understood, seem determinable. It is evident, therefore, that one may attack the problem of the origin of Andean life with far greater hope of success than attends researches of this nature in regions whose geological and faunal history are lost in an incalculably remote past.

Altitudinal life is most highly developed in the mountains of equatorial regions. Here, from a tropical base, one may look up to snow-crowned summits and find all the climatic and faunal zones represented on the intervening slopes.

Standing, for example, at Guayaquil in the coastal region of Ecuador, one may under favourable conditions see the peak of Chimborazo over 20,000 feet above one. To reach snow-line at 14,500 feet one must pass through the tropical, sub-tropical, temperate, and alpine or paramo zones. Each zone has species which are peculiar to it. In Ecuador, a region to which I have devoted the past six years, we have found that, omitting marine and migratory species, one-third of the total bird-life is altitudinal; that is, it is found above the basal or tropical zone. Some families of birds are much more susceptible to zonal evolution than others. Of the 147 species of humming-birds found in Ecuador, for example, no less than 81 are found above the tropics, one indeed living at the level of perpetual snow.

Whence came these distinct species of birds? To determine their origin and ascertain the factors which confine them to certain zones has been the principal object of our researches in Ecuador and in Colombia. The subject is too large to be considered in this connection, and I shall refer only to that part of it which is related to our explorations in Chile.

It appears that the zonal or altitudinal life of isolated mountains is far more limited than that of those which form part of an extended range. Thus Ruwenzori in equatorial Africa is known to possess only 95 zonal species of birds, while a corresponding area in Ecuador would yield no less than 300. It follows, therefore, that in studying the life of mountains we have to consider not alone their height but their length. The length of the Andes, for example, is coextensive with that of South America itself; and there is evidence that they were formerly connected with the mountains of Central America, and through them with those of

Western North America. In attempting, therefore, to ascertain the origin of Ecuador's zonal forms our field extends from one end of the Western Hemisphere to the other.

But in hunting for ancestral forms we must consider not only the probable place of origin but also the matter of habitat requirement. That is, the immediate ancestors of forest-haunting birds must be looked for in other forests ; those of plains in other plains. In a word, we have found that the birds of Subtropical, and even Temperate Zone forests have in large part come from the forests of the Tropical Zone. On the other hand, most of the species of the high Andean plains of the arid Temperate and Paramo Zones have come from the plains of the South Temperate Zone. To illustrate : the first Condor it was my fortune to observe was at an elevation of 15,000 feet on Chimborazo, while the last one seen was at sea-level in Southern Patagonia. The latter region I believe to be the bird's true home, whence, with the elevation of the Andes, it has extended its range towards the Equator, increasing its altitude as it decreased its latitude, and thus always remaining in a climatic zone resembling that from which it started.

Humming-birds, no less than Condors, are subject to the laws which govern the distribution of life. The Giant Hummer (*Patagona gigas*) inhabits the interandine valleys of the arid Temperate Zone as far north as the Equator, and in Chile it is found in the Temperate Zone at sea-level.

The humming-birds of the genus *Oreotrochilus* inhabit the Paramo Zone of Ecuador and the same zone in Chile. Each bird true to its own zonal boundaries ranges through the 2000 miles between Chile and Ecuador, but in neither country does it cross the few hundred feet which would take it from one zone to another.

There are many similar cases, and it was primarily to determine the place of origin of certain birds inhabiting the high Andes of Ecuador that I have visited Chile. With this explanation of the object of my several reconnaissances in Chile, we may enter that country less as specialists in zoogeography than as travellers who would gain some general, broad conception of its dominant characteristics as they affect man as well as birds.

We are at once impressed by the fact that Chile extends through 39 degrees of latitude, and has a length therefore of nearly 3000 miles. We further observe that the climate is highly modified by wide variation in rainfall, extending from none at all in the northern part of the country to as much as 275 inches annually in southern Chile. If northern Chile were humid, which would imply the absence of the Humboldt Current, we should doubtless find a well-developed subtropical fauna there, but the excessive aridity which prevails in this region renders it almost lifeless, and hence prohibits marked faunal expression. There is, however, a suggestion of a subtropical element at least north of Tarapacá.

As we proceed toward the south we approach the region of annual rainfall. Its influence on the flora and hence the fauna is first observable at about S. lat. 30°. With a gradually increasing rainfall this region extends to S. lat. 37°, where the annual rainfall is sufficient to produce forests; and if we confine ourselves to the Pacific coastal region we shall find that this forested region extends to the islands south of the Straits of Magellan.

The coastal region of Chile therefore includes intensely arid, semi-arid, and excessively humid divisions. The first has a suggestion of subtropical life, the second contains a well-marked semi-arid temperate fauna, the third a small but distinct humid temperate fauna.

It is in the second section that we shall find the ancestral forms of several species of birds which now inhabit the arid Temperate Zone of Peru, Ecuador, and Colombia.

The third or forested region of Chile is separated from the nearest forested area, that of north-western Argentina, by a treeless region some 700 miles in width. It has contributed nothing to the life of the Equatorial Andes.

The Temperate Zone in Central or semi-arid Chile extends upward to an altitude of about 600 feet, or to the upper limit of the scrubby growth which characterizes this region. Beyond this lies what is locally known as the Puna, which we shall find to be the zonal equivalent of the Paramo in Ecuador. While the latter country has four life-zones between sea-level and snow-line—Tropical, Subtropical, Temperate, and Paramo—only the last two are present in Chile, and in each one, as shown above, we find that either the same or representative forms of bird-life are common to both countries.

In the belief that all altitudinal zones have originated at sea-level, it remains for us to determine in what latitude the Paramo or Puna Zone has its basal beginning. This we shall find in that part of Chile which geographically belongs to the plains of Western Patagonia, and which, although it is east of the Andes, nevertheless drains into the Pacific. This apparently impossible topographic condition (which is said to have caused no small degree of confusion in determining the Chilean–Argentine boundary) is due to disconnections in the still ascending Southern Andes, through which the waters of the Pacific reach the western margin of the plains of Southern Patagonia, which consequently drain into them.

Described in terms of their resources, these four natural areas may be known as Nitrate Chile, Agricultural Chile, Forested Chile, and Sheep-raising Chile. The first doubtless never supported a large indigenous population, and is to-day inhabited chiefly by Bolivian Indians and by Chileans from the south, both imported as labourers in the copper-mines and nitrate fields, while the seaports have a heterogeneous population. The second, with Santiago as its centre, is Chile of the Chileans;

1. *DESERT CHILE: Mt. San Pedro, N.E. of Chuquicamata. Lat.* 21° 53′ *S.*

2. *Chuquicamata Copper Mine. Lat.* 22° 17′ *S.*

3. *PASTORAL CHILE: Near Santiago. Lat.* 33° 27′ *S.*

4. *Mouth of the Rio Aconcagua. Lat.* 32° 55′ *S.*

5. *Upper Aconcagua Valley above Los Andes. Lat.* 32° 50′ *S.*

6. *Puerto Montt. Lat.* 41° 28′ *S.*

while an area at its southern border, with Temuco as its centre, may be called Chile of the Araucanians. Here still exist large numbers of these fine indigenes living on the small farms allotted to them by the government.

It is not improbable that the continued existence of these Indians is in a large measure due to the protection afforded them by the great forests which formerly covered the region in which they lived. While, therefore, their representatives on the open plains of Argentina and Patagonia were practically exterminated at a comparatively early date after the Spanish occupation, the Araucanians, it will be remembered, remained undefeated after ninety years of continuous warfare with the representatives of Spain. Darwin speaks of these Indians as "good-sized men; their cheek-bones are prominent, and in general appearance they resemble the great American family to which they belong; but their physiognomy seemed to me to be slightly different from that of any other tribe which I had before seen. Their expression is generally grave, and even austere, and possesses much character. . . ."

It is not impossible, also, that their range may in part have been determined by that of the Araucaria pine (*Araucaria imbricata*), the seeds of which, ground into flour, formed an important part of their food supply.

This tree is confined to the Andes between about 39° and 43° S. lat., and it is also found locally in the coast range within these limits. In the Andes it first appears at an elevation of some 3000 feet, and grows thence to timber-line at about 6000 feet. The present compared with the known past distribution of the genus *Araucaria* and its near allies is a warning to biogeographers not to place too much emphasis on existing conditions. In South America it now grows only in Chile, south-eastern Brazil, and the adjoining parts of Uruguay. But we recall the Norfolk Island Pine of this same group with a related species in Australia. Moreover, in South America *Araucaria* has been found fossil in southern Patagonia and the Falkland Islands, and it is said that there is a fossilized specimen of *Araucaria* in the Santiago Museum from what is now the absolutely barren region of Tarapacá. Darwin also found the fossilized stumps of trees "partaking of the character of the Araucarian family" at an elevation of 7000 feet in the Andes west of Mendoza, which he concluded grew on the shores of the Atlantic when that ocean came to the foot of the Andes. "Vast, and scarcely comprehensible," he writes, "as such changes must ever appear, yet they have all occurred within a period, recent when compared with the history of the Cordillera; and the Cordillera itself is absolutely modern as compared with many of the fossiliferous strata of Europe and America."

To resume our outline of the distribution of men in Chile: Immediately south of the region occupied by the Araucanians and stretching from Valdivia to Puerto Montt, we shall find Chile of the Germans.

Landing first at Valdavia, these people have conquered the heavy forests which then covered this region, have converted it into pastures, and literally made it a land flowing with milk and honey.

The inhabitants of the island of Chiloe, south of Puerto Montt, are sufficiently unlike those of the mainland to be known as Chilotes, rather than Chileans. This difference doubtless has its foundation in the original Indian stock which forms a large percentage of their blood. Furthermore, protected by an insular environment, they have not encountered that type of aggressive invasion against which the Araucanians struggled so valiantly and to which Darwin attributed their "independence of manners." The principal occupation of the Chilotans is the raising of potatoes. Here, indeed, we are in the original home of the potato. It is true that the potato was first discovered by the Spaniards on the tableland of Ecuador; but we have seen that we must seek the point of origin of altitudinal species at a lower level than that at which they occur. The majestic Condor no less than the humble potato is subject to this law. Both have evidently extended their range from sea-level in the south Temperate Zone northward through those altitudes at which this zone is found; and although one is apparently a master of the air while the other is rooted to the ground, the range of each is determined by essentially the same factors.

With the exception of a small settlement in the Guaitecas, across the Channel from Southern Chiloe, the Pacific coast from this point southward to Cape Horn is no more settled to-day than it was when the *Beagle* surveyed its waters. Doubtless indeed there are fewer human beings in this region now than then. Wholly unsuited climatically to the wants of civilized man is the home of the Alacalufes, or Channel Indians, who in spite of the fact that they live in the Temperate Zone, are one of the lowest of human races. Feeding largely on shellfish, having neither permanent home nor tribal organization, isolated from contact with other races, living their lives in caves, their entire environment appears to be devoid of factors which would stimulate and promote development. Comparatively numerous in Darwin's day, they are now near the verge of extinction. Estimates in regard to their number vary, but it is generally said that not more than 150, divided into three groups, now exist.

We encountered representatives of the most northern of these groups in the Messier Channel near the English Channel, where on our southern voyage and in returning we met two canoes, one containing six men, the other four women. In place of the word "yammerschooner," meaning "give me," the constant use of which by the Fuegians Darwin describes so humorously, these Indians in coming aboard our steamer called eagerly for "guachacaya," or rum, in return for which they offered otter-skins. Among the Indians who came aboard the steamer on our return trip was a woman with a very young baby. The woman wore a single garment, the baby was naked. It was raining, cold and

cheerless, and when after dark the Indians returned to their miserable canoes, doubtless to pass the night without shelter on the near-by shores, I recalled an essentially similar scene described by Darwin, evidence that these Indians exist much as they did a century ago.

Finally, we come to that part of Chile which lies east of the Andes, but possesses a Pacific drainage. Here the changes are more pronounced than in any other part of the region visited by Darwin. This is British Chile. Gone are the Patagonians, and in their place are rugged sheep herders from the Falklands, Australia, New Zealand, the north of England, and from Scotland. The days of the guanaco are numbered by the wire fences which confine millions of sheep to their ranges, and prevent their wild predecessor from seeking protection in Andean valleys during the winter. I was told of 6000 guanacos found dead in one fenced enclosure as a result of exposure to the severe winter of 1913.

I motored 150 miles northward from Punta Arenas on the straits, and always the road was bordered by strong seven-strand wire fences. At the end of this journey, on which we were never more than a few hundred feet above sea-level, we reached a port on the Gulf of La Ultima Esperanza where the waters of the Pacific wash the plains of Patagonia. Here 10,000-ton steamers enter to load with frozen sheep, which at this time (January 1924) were being killed at the rate of 4200 daily.

Viewed in connection with the general distribution of land and water in the southern Andes, it seems clear that this connection of the plains and the Pacific marks a stage in the period of elevation which now prevails in that region. Apparently this elevation has been greater at the northern than at the southern end of the once submerged area. In the north, in what is known as the lake region of Chile, the arms and fiords of the Pacific are completely separated by the Andean uplift, and the disconnected portions lie on opposite sides of these mountains.

A familiar illustration of this type of topography is supplied by the section from Lake Llanquihue, in Chile to Lake Nahuel Huapi in Argentina. Here the divide, which is also the boundary-line between the two countries, attains an elevation of only 3000 feet, the lowest pass in the Andean system from this point northward to Colombia. The range is evidently, therefore, too low to deprive its eastern slopes of Pacific-born rainfall, and heavy forest growth extends to the shores of Lake Nahuel Huapi. Thence eastward the change is rapid, and timberline is soon reached without altering one's level under the influence of factors which are expressed horizontally rather than vertically. With no more rapid progress than is supplied by the steamer on Nahuel Huapi one may therefore pass within a few hours from luxuriant forest growth to arid plains.

Lakes Buenos Aires and Viedma, at the eastern base of the mountains, appear to have been created by the Andean uplift, but at the great lagoon

or bay of La Ultima Esperanza the connection with the Pacific has not yet been severed. Still farther south we find evidence of less advanced uplift in the Straits of Magellan which still afford a complete connection between the Pacific and the Atlantic.

The influence exerted by climate on the development of the fauna of temperate South America is strongly illustrated by the representatives of the genus *Homo* in Central Chile and their representatives on the plains of Argentina. Their descendants of to-day in their physical attributes give evidence of the favourable environment under which they have lived. Nor has climate in its effects been restricted to the indigenes. The racial affinities of more recent additions to the Chilean population have also been determined by climatic conditions, and just as we find Temperate Zone birds of Patagonian plains seeking their proper level in the high equatorial Andes, so have people of the north Temperate Zone sought congenial homes in the south Temperate Zone. This is true from the Santiago region southward, but in no part of Chile is it more pronounced than in the region of which Punta Arenas is the port. Favourable alike for sheep as well as for sheep-men, it is a Scotch-English, rather than a Latin-American country.

A pond ringing with the clink of skates on ice is not a scene we associate with South America, and it is only in recent years that football fields and golf courses have become familiar adjuncts of those South American communities where Britons have taken up their abode. Certainly the most southern golf course in the world is found at Punta Arenas, and, so far as I am aware, the highest one is situated on the tableland above La Paz, Bolivia, at an altitude of about 13,500 feet, both, it is needless to say, of British origin.

While the subject lies somewhat outside the naturalist's field, I nevertheless have no doubt that had Darwin observed the results which have followed the introduction of football into South America, he would not have failed to comment on them. To learn how to "play the game," whether on the field of sport or market-place of trade, is by no means one of the least important lessons of life, and when not alone the individual but the nation shares in the result we are assuredly dealing with influences of far-reaching significance.

Consider, for example, what it meant to the Republic of Uruguay to win the Olympic Football Championship! Possibly no event in the history of the republic has done more to arouse a national consciousness irrespective of political faith. And when later the returning heroes added to their laurels the championship of South America, the joy of the people of the Purple Land was complete.

The greater part of the vast territory which we have reviewed so hastily was traversed by Darwin; and what a remarkable record this young man in his twenties has left us of his experiences! With each re-reading of the 'Journal' one is impressed anew by the breadth of

7. *FOREST CHILE: Lake Llanquihue and Mt. Osorno. Lat.* 41° *S.*

8. *El Tronador between Llanquihue and Nahuel Huapi. Lat.* 41° 6′ *S.*

9. *Laguna Fria between Llanquihue and Nahuel Huapi. Lat.* 41° 5′ *S.*

10. *Coihue Forest, western slope of Andes. Lat.* 37° *S.*

11. *Forest at western end of lake Nahuel Huapi. Lat.* 41° *S.*

12. *Plains at eastern end of lake Nahuel Huapi. Lat.* 41° *S.*

his interests, the keenness of his observations, the profundity and soundness of his conclusions, and always by the ardour of his love of nature.

With little more than superficial training in zoology or geology he nevertheless made important contributions to both these branches of science. In his autobiography ('Life and Letters,' vol. 1) he states that his "various special studies were, however, of no importance compared with the habit of energetic industry and of concentrated attention to whatever I was engaged in, which I then acquired. Everything about which I thought or read was made to bear directly on what I had seen or was likely to see; and this habit of mind was continued during the five years of the voyage."

In other words, the 'Journal' is a remarkable book because it was written by a remarkable man. With equal zeal and understanding, he writes as a geographer, geologist, and biologist, but we see more of the real man in his sensitive response to his environment. On reaching sunny Central Chile, after being for months under the cloudy skies of the southern islands, he writes: "What a difference does climate make in the enjoyment of life! How opposite are the sensations when viewing black mountains half enveloped in clouds and seeing another range through the light blue haze of a sunny day! The one for a time may be very sublime; the other is all gaiety and happy life."

Darwin's many-sidedness made him an admirable geographer. The physiography, formation, climate, resources, people, and history of the countries he visited all claimed his attention. One cannot travel far in Chile without crossing Darwin's trail. To the naturalist these Darwin associations are inexpressibly interesting, and with your permission I will present several here, as they relate to the country, its history, its people, its birds, and as they show the still existing influence of Darwin's visit.

On 6 September 1834, travelling on horseback, Darwin reached the town of Rancagua, and the following day "turned up the valley of Cachapoal to the baths of Cauqenes," at which he arrived in the evening. The buildings, which he describes as a square of miserable hovels, each with a single chair and a bench, have been replaced by more pretentious edifices, and when I visited this spot in January 1919 there was a small museum containing a collection of birds attached to the hotel, the establishment of which was an indirect result of Darwin's 'Voyage.'

In 1860 a young Englishman, named Edwin C. Reed, acting on Darwin's advice, made a journey of exploration to Chile, where he passed the remainder of his life. He did much to promote interest in the study of nature in Chile, founding a museum at Concepcion, and it was through his influence that the little museum was erected at Cauqenes. It has since fallen into disrepair, and its collections have been removed to the National Museum at Santiago. Darwin remained five days at Cauquenes and rode up the valley to the farthest inhabited point, doubt-

less over a route now in part occupied by the railroad which leads from Rancagua to the copper-mines of El Teniente, a distance of some 75 kilometres.

On a subsequent land journey, in March 1835, Darwin crossed the Andes from Santiago to Mendoza, over the Portillo Pass. In this city also may be found a museum which, removed by one more generation, owes its origin to Darwin. In Mendoza, Carlos Reed, a son of Edwin Reed, founded this admirable institution, developed its collection, and for several years served as its director. It is worthy of record that the first name to be written in the visitors' book is that of Theodore Roosevelt, who visited Mendoza while *en route* to Chile in the latter part of 1913. Carlos Reed is now living in Santiago, where he plays an important part in the advancement of scientific interests in Chile, and is therefore a living example of the Darwinian influence.

Darwin returned to Santiago over the Uspallata Pass, and travelling rapidly reached Los Andes in ten days. The journey is now made by rail in twelve hours. In following Darwin's trail over the Andes as we leave El Puente del Inca we cross the routes of Fitzgerald and Conway *en route* to Aconcagua.

Descending from the highlands of the Paramo Zone to the lowlands of the Temperate Zone, we pass the outlying Campaña, or Bell Mountain, on the summit of which Darwin spent the day of 17 August 1833, " and," he writes, " I never enjoyed one more thoroughly."

While in the harbour of Valdivia Darwin crossed the bay to the fortified heights captured by Cochrane. The guns which the officer in command assured would stand " two discharges " are now mere relics. In one of the enclosures of the fort I was shown what appeared to be a small symmetrical hill, and was told that it was lime brought by the Spaniards for use in enlarging the fortifications. Acid test showed it to be limestone, and I subsequently found the story confirmed by Darwin in his account of his visit to this historic place.

At Puerto Montt in January 1924 I joined Lord William Percy and Mr. Frederic C. Walcott in securing a small steamer for a cruise to the Guaitecas Island, south of Chiloe. This whole region is filled with memories of Darwin, who, between 21 November 1834 and 4 February 1835, explored it both ashore and afloat.

Among all the Darwin associations which we encountered here none connected us more closely with the *Beagle's* cruise than to discover that the captain of our little vessel was the son of a man who served on that vessel under Fitzroy. Subsequently he settled on Chiloe, married a Chilotan, and evidently became a person of importance. Yates (pronounced " Yah-tees " in Chile) was his name, and there is a town, an island, and a mountain named for him.

His son, our captain, was fully aware of his distinguished parentage, and evidently tried to be worthy of it. He spoke little or no English,

and had never been east of the Pacific ; but it was clear that his measures of accuracy were not those of the country of his birth. If he said that the vessel would leave at a given hour, at that hour we sailed ; and when he told me that we would find Penguins nesting in the Guaitecas, I at once formed a mental picture of row after row of erect little forms drawn up in line which we would unquestionably encounter on some barren, rocky islet.

But when we reached the Guaitecas every rock and island was densely forested to the water's edge. Nowhere was there a place which seemed suitable for Penguins. Could it be possible that in his desire to please our captain had ventured an unwarranted prediction ? Great as was my desire to meet penguins at home I hoped even more strongly that the captain would continue to live up to Darwinian standards of truthfulness. Imagine therefore my relief when, in response to my somewhat hesitating query concerning the whereabouts of the Penguins, the captain quickly pointed to the island off which we were anchored and said, " Aqui estan, Señor " (Here they are, Sir). The reply, however, only served to renew my doubts of the captain's veracity. Every foot of shore-line was concealed by overhanging limbs, and from shore to summit the ground was covered by trees and dense luxuriant undergrowth. Surely this was no place for penguins ! The captain, however, with unbroken confidence had ordered a boat to be lowered, and within a few minutes we were pulling slowly along the fringing limbs.

The whole performance seemed to me to be ridiculous. It could not be possible that the captain and I were applying the same name to different birds, for we both used the local " pajaro niño " (child-bird) by which the Penguin is universally known in these waters. But whatever a Penguin may be in the realms of ornithological classification he is certainly not a " perching bird," and it seemed equally certain that only a perching bird could exist in the dense growth which we were passing. Suddenly the captain said, " Van aqui " (They go here), and ordered the boat's bow to be shoved beneath the overhanging branches. A shelving shore of rocks was now revealed, and worn in it a narrow pathway ran from the water and disappeared in the undergrowth. Beyond all doubt some form of aquatic life made its home in this island forest, and without pausing to ask further questions I took the trail. As it left the rocks and reached the ground it widened from 1 to 2 yards, and shortly began the ascent of the island at an angle of about 45 degrees. Here the ground was cleared of leaves and the roots exposed as though a rope ladder had been laid down to assist the climbers.

When some 40 feet up a small trail left the main travelled road and disappeared in a hole beneath a fern growing from the side of a bank. " Casa del pajaro nino," said the captain, who seemed to take the whole experience as an everyday event and showed no signs of the excitement which I no doubt exhibited, though I did not realize it at the time. The

" house " however was empty, and we resumed our explorations. These soon led us up the broad highway to the rounded summit of the island, about 75 feet above the water. Here the ground was trampled and cleared for many square yards, forming a plaza, and the neighbouring banks and slopes were punctured with openings. One after the other was examined, and my suspense was quickly ended by the discovery of two young Penguins nearly large enough to leave the nest. Later other young birds and several adults were found, but it was evident that we had arrived at the close of the nesting season. What a remarkable scene this island must have presented earlier in the season! Then the highways and byways were filled with the quaint little figures hurrying to and fro, climbing and descending the rope stairway in pursuance of their family cares.

The Penguins had chosen a rarely beautiful place for their home: impressive in the grandeur of their trees, the luxuriance of their undergrowth, and the wealth of parasites and vines which cover limb and trunk, these south temperate forests are nevertheless friendly and hospitable.

One never becomes really intimate with a tropical forest. Attempt to establish close relations with it and you soon discover to your sorrow that you have become the victim of scores of relentless insect pests. But in southern Chile one may stretch himself in comfort on the forest floor with the assurance that he will be kindly received. So reclining I have had the little Cheucau (*Pteroptochus rubecula*), author of an endless series of surprising and sometimes startling notes, hop on the toe of my Brobdingnagian boot and look me calmly over before continuing on its way. Darwin describes the habits of this little bird, and states that it is " held in superstitious fear by the Chilotans on account of its strange and varied cries." And so without thought of snake, tick, or " red-bug " I made myself at home in this resort of the Penguins. Occasionally I saw one of these little child-birds trotting gravely along on his appointed task; more often I saw some of the other bird inhabitants of this favoured island. A flock of Paroquets (*Microsittace*) screaming flew through the treetops; the first Magellan Woodpecker I had ever beheld, a splendid black bird 15 inches long, with a flaming scarlet crest, investigated a dead limb nearly over my head; and Ruby-crowned Hummingbirds (*Eustephanus*), attracted by the abundance of flowers, whirred from one blossom to another. Penguins, Parrots, and Humming-birds—here indeed was an avian association rivalling in strangeness the fauna of the ' Swiss Family Robinson '!

Through my enjoyment of this novel experience ran a strand of keen satisfaction that the Darwinian association was safe in the captain's keeping. When after repeated evidences of his dependability I tried to express to him my admiration of his standards, saying, " Assuredly, captain, you are a man of your word," he drew himself up, tapped his chest, and replied, " Soy Ingles " (I am an Englishman).

13. *The Guiatecas Islands: home of penguins and humming-birds. Lat.* 44° *S.*

14. *Adult penguin at entrance to trail.*

Phot. C. Veiga.

15. *Estero Eberhardt, Last Hope Inlet. Lat.* 51° 40′ *S.*

16. *SHEEP RAISING CHILE: North of Punta Arenas. Lat.* 53° *S.*

17. *Winter sports at Punta Arenas. Lat.* 53° 10′ *S.*

Here indeed was a tribute to the strength of the Darwinian influence, which renews one's faith in the heritable value of tradition as it lives in the character of a nation.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: It is a long time since this Society has been addressed on the subject of that very interesting region, Chile; that enormous country, about 3000 miles long, which has many different climates and many different physical characteristics. We are fortunate to be addressed upon that subject by a most distinguished member of the American nation, which has been for many years devoting so much of its interest and its energy to the exploration of South America, and doing so with that amazing thoroughness which we have learned to connect with America. Dr. Chapman, who is to address us to-night, had, I believe, been visiting South America for something over thirty years, primarily as a naturalist but also with an eye and an interest for almost everything else that the country contains; in particular, with a deep reverence for the Englishman, Darwin, who as a young man of twenty made the most notable journey in Chile that any Englishman has ever made. Dr. Chapman will speak to us with regard to certain traces that he still finds of Darwin and of Darwin's influence in the country. I am glad to say that we have with us this evening Major Leonard Darwin, who was at one time President of this Society, and who will, I hope, say something after the lecture. I will not stand between you and Dr. Chapman, except to say that those of you who know New York will realize that I am not exaggerating when I say that he represents what is perhaps the most magnificent natural history museum in the world, and that he is going to speak to us now upon a subject which he has made his own.

Dr. Chapman then read the paper printed above, and a discussion followed.

Major LEONARD DARWIN: I have nothing of my own individual knowledge to contribute to the discussion which I hope will follow this extremely interesting lecture, but I am very glad you have given me an opportunity of saying how much I enjoyed it and how much I appreciate all the very kind things Dr. Chapman has said about my father. My own knowledge of things connected with Chile is derived from a recollection of what I used to find in a cupboard under the staircase in my father's house. There we found, as boys, stirrups made of wood and spurs with big rowels. These we used to play with, and, as you may imagine, those interesting relics of the voyage of the *Beagle* have now disappeared into space.

It occurred to me however, when I knew I was coming here, that it would be of interest to consult a document which I have in my possession, and that is a typewritten copy of the original manuscript of the 'Voyage of the *Beagle*' as my father wrote it in South America. What struck me most of all was how very little he had altered what he wrote actually on the spot when he prepared it for publication. When you are reading the 'Voyage of the *Beagle*,' you are reading what was written by a young man of twenty-six years of age at the time he was in Chile—a young man who had not long left the University of Cambridge, that great University where he had learnt to shoot and to ride very well; where he had retained a certain smattering of the Classics; and where his scientific instruction seems to have come in purely by chance. In those circumstances one does wonder how it comes about that this Journal can still, I think, be read with interest after a lapse of ninety years. Dr. Chapman has given the clue: it being that my father was only thinking of the way to express

what interested him so intensely in the most simple language he could use. He was not thinking of making any effect. I can remember perfectly well the look of animation that used to light up his face when anything was said about his doings in South America.

I have said that my father altered very little what he had written. There are a few sentences, however, which he did leave out, and these omissions may be of interest. He felt, unlike some other travellers, that his own discomforts, even when ill, would not be of interest to others, and he therefore omitted such a sentence as " . . . had the uncommon luck of obtaining some clean straw for my bed." He went on to add a sentence which implied that stinking horse-cloths, even if accompanied by clean straw, do not make a very good bed for an invalid. Another sentence in regard to Valparaiso was omitted for fairly obvious reasons. " Already I have met with several people who have read works on geology and other branches of science, and actually take interest in subjects in no way connected with bales of goods and pounds, shillings and pence." He alluded elsewhere to the extraordinary courtesy he had received everywhere in Chile, and he may have felt that it was hardly courteous to sneer at those who only took interest in pounds, shillings and pence, but who had treated him so kindly. My own thoughts when reading this sentence led me to wonder whether we have advanced at all since those days? Would you now find many people in a commercial town anywhere who had read books on geology or even geography? I rather doubt it.

He had seen—I do not know where—some very fertile land which was only inhabited by Indians, and on this subject he used the following words: " My friend the Padre of Cudico bitterly regretted that it [the land] should be so wasted, and wished with Christian humanity that all the provinces would unite and make a complete end of the Indian race." I do not wonder that he thought that this might be misrepresented. None of us who are interested in eugenics have dared to go as far as that, yet we are constantly finding our ideas misrepresented.

May I give one other quotation from the manuscript of the ' Voyage of the *Beagle*,' even though it has been already printed? After remarking on the scarcity of animal-life in Chile, he used these words: " It seems a not improbable conjecture that the want of animals may be owing to none having been created since this country was raised from the sea." It has often been said that my father was merely swimming with the tide when introducing the idea of organic evolution. If so, apparently this tide of opinion had not affected him when he wrote that sentence. But, as Dr. Chapman has said, there are elsewhere signs that it was in Chile that the first notion of organic evolution began to enter my father's mind, and therefore, historically, we may connect his journeys in Chile with the inauguration of the idea of organic evolution as far as it depended on him. I thank you, Dr. Chapman, again most sincerely for all that you have said about my father.

Dr. P. R. LOWE (British Museum, Natural History): During the last week I was present at the International Ornithological Congress at Copenhagen, and while there it was my good fortune to listen to Dr. Chapman on several other occasions while he lectured to us on various interesting subjects. It also fell to my lot to get up, as I do now, and congratulate him on his excellent addresses. I did so then and I do so now all the more gladly because it seems to me that Dr. Chapman and his colleagues in America have by their continuous and well-planned work done much to raise the study of ornithology to a higher plane than it has ever occupied in the past.

In the old days, when expeditions were sent out to collect birds in this country or that, the collectors were inclined to wander about rather aimlessly, collecting as many birds as they could without any very carefully considered plan or definite object in view. Having done this they brought them home, and all their efforts were then concentrated on the single purpose of identifying them or giving them names if they were new to science. This, alas! in too many instances was the end of the story; for the next step was to transfer the collection to the safe keeping of cabinets, where it was either forgotten or awaited the day until some one came along to study it or ascertain if the names were correct.

Dr. Chapman, aided by his colleagues, goes further. He is not content just to collect birds and having collected them to label them and there make an end. He wants to find out the origin of the bird fauna of the countries in which he collects on such a comprehensive scale. The American nation has a way of doing things on a big scale. It sends expeditions to such countries as Colombia and Ecuador, and there its collectors and investigators make magnificent collections on a completely representative scale; but in addition to that they endeavour, as I have said, to work out the problem of the origin of the faunas they find there. To do that they get back, in the case of such countries as Colombia and Ecuador, to something basic. They begin their study at a geological period when the long chain of the Andes had as yet not commenced to rise from sea-level, and from that point follow the evolution of successive altitudinal zones, and along with it the evolution of successive avian zones with their distinctive species or subspecies. As Dr. Chapman has told us, the question of the exact process by which these successive bird faunas became established is not only one of extreme interest, but it is also one of great complexity; but in attempting to unravel the problem it seems to me that we ornithologists owe a great deal to Dr. Chapman. He has set us a magnificent example of how to set to work to study ornithology as it should be studied.

Major R. W. G. HINGSTON: Having been scarcely any nearer to Chile than the platform of the Æolian Hall, I feel somewhat reluctant to say one single word. My only claim to say anything is the claim which every naturalist who has lived within the last fifty years possesses, that of following, both in spirit and in thought, along the path of Charles Darwin. I should have loved to see Dr. Chapman's birds in their natural haunts; but perhaps most the condor. It must be a wonderful sight to see those immense vulture-like birds soaring and wheeling at an altitude of 15,000 feet around the precipitous cliffs of the Chilean mountains. Those birds are, of course, vulturine; they tear the flesh from carcases and leave behind the bare bones. They are the scavengers of the Andes. In the Himalaya, however, we go a step further. We can beat Chile in our scavenging operations. For not only have we vultures which tear the flesh from the bones, but there is the lammergeyer, which actually destroys the bones which other vultures leave. It is interesting to watch one of those lammergeyers at work. It finds a pile of bones, picks up one and carries it to a height of 50 or 60 feet, and then allows the bone to fall in the hope that it will crash to pieces on the ground. Then it comes down and eats up the fragments. If the bone does not break, then the bird seizes it again, carries it up to 100 or 150 feet and repeats the process, and in the end it manages to devour all the particles of the bone.

Dr. Chapman mentioned earlier in his lecture the elevation of the coast-line of Chile, and when one thinks back on Darwin's voyage one recollects how frequently he referred to the same thing and his great delight at finding fossils, I think on one occasion at 14,000 feet, showing how the land had been

elevated to that height since the Secondary period. Indeed, Darwin was interested in everything. When one reads his 'Voyage' one realizes that he was the complete traveller. Everything fascinated him—human affairs, animal-life, plant-life, geological formations, geographical structure. As we read his 'Journal' we find him at one time considering the habits of some obscure animal, and at another the permanency of continents and oceans. He was a complete traveller, and it is that which makes his journey so delightful.

There are some who imagine that Darwin's natural-history problems are out of place before a geographical audience; but I greatly doubt it. The complete traveller, if I may use the term, is not only the man who goes abroad and brings back a map accurate in every detail, but the man whose mind is receptive to all natural-history problems. Such a man gains greater enjoyment for himself and brings back greater instruction and pleasure to others. Dr. Chapman has shown us how natural-history problems can be placed before a geographical audience, and, I think, has added more to our interest by doing so. I hope that interest will not be merely transient, but that it will tempt some of us when we return home to take again from the shelf and read with increasing pleasure that most delightful of all traveller's stories, Charles Darwin's 'Voyage of the *Beagle*.'

The PRESIDENT: Are there any questions that any one would like to put to Dr. Chapman? If not, I will, with his consent, call upon Lord Grey to express our thanks for the extremely interesting evening which Dr. Chapman has given us.

Viscount GREY OF FALLODON: I rise to move a vote of thanks to Dr. Chapman, in which, I am sure, you will all enthusiastically concur. I am not qualified to make comments on the subject of his address. I have never been in the regions of which he has spoken, but I have heard other lectures, and I should like to congratulate Dr. Chapman upon the elocution and the method and arrangement of his lecture. He has given us a model of how to lecture. Further, those of us who know Dr. Chapman, realize what I think even those who did not know him before his lecture must now also realize: that he is one of those in whom knowledge quickens feeling, and that quickening of feeling gives a special gift of imparting the knowledge which he acquires to others; and that sense of enjoyment which he conveys of the knowledge which he has acquired is an incentive to others to acquire it too.

Dr. Chapman is a distinguished representative of the National Museum of Natural History in New York, which is such a credit to the great country to which it belongs. You will have gathered from what Dr Lowe said what an immense advantage to the Museum it must be that its representatives should be enabled not only to sit in the Museum and arrange specimens, but to travel, as Dr. Chapman travels, not only on the occasion he has told us of, but on others, to see things in their natural setting, to form opinions as to their origin and habits, and how they came to be where they are. I think great benefit would be derived if the British people would consider whether more could not be done to enable representatives of the British Natural History Museum to do more of the same sort of work as Dr. Chapman is doing for his great museum. I ask you now to pass a vote, which I am sure you will all receive with unanimity and acclamation, of cordial thanks to Dr. Chapman, and to express our appreciation of his lecture this evening.

The PRESIDENT: You have expressed, as I expected you would, your thanks to Dr. Chapman. I have nothing that I can usefully add after the very appropriate and very sincere remarks that have been made by more than

one speaker. Personally, I have heard no lecture which has taught me as much in so short a time; and I think that this result was very largely due, as Lord Grey has said, to the method of the speaker. I can only endorse what Major Hingston has said with regard to the degree in which the interest of a lecture of this kind to a geographical society is enhanced by the lecturer's interest in and knowledge of natural history. I have had a long experience of lectures here, and I can pick out two or three in my memory which have remained there because the speaker was not interested solely in the rocks, solely in the relief of the country dealt with, but also in the myriad populations of the soil. I quite agree with Lord Grey that Dr. Chapman, in addition to interesting us, has given a very valuable exposition of how to deliver a lecture of this kind: first of all, how to frame it; secondly, how to deliver it. I hope he will accept the most cordial thanks of the audience.

THE STRUCTURE OF THE EASTERN FLANK OF THE RIFT VALLEY NEAR NAIROBI

H. L. Sikes, Director of Public Works, Kenya Colony

Folding map follows p. 456.

PROBABLY it may be regarded as established that the series of relatively straight steep-sided valleys or troughs which extend almost continuously from the Jordan Valley through the Red Sea, Abyssinia, Kenya, Uganda, Tanganyika Territory, and Nyasaland into Portuguese East Africa originated by tectonic movement. The literature on the structure of this zone of crustal weakness is considerable. Detailed work has been carried out on many isolated portions of it, and the records of the results of traverses have provided information regarding the outlines of the topography and structure of almost all the remainder. The evidence available up to the year 1921 was collated and reviewed by Professor J. W. Gregory in 'The Rift Valleys and Geology of East Africa,' 1921, in the light of his researches in Kenya Colony; and a theory of the origin of these valleys by tension, which is widely accepted, is elaborated in that work. Additional evidence supporting their origin by tension is adduced in a paper by him entitled "The Structure of the Great Rift Valley," in *Nature*, 6 October 1923. It is to be expected that as mapping and study of portions of the troughs progresses, the nature of the movements which controlled the formation of this unique series of valleys, extending over one-sixth of the Earth's circumference, will become clearer.

The object of this paper is to adduce evidence regarding the physiography of a small portion of the eastern flank of the trough which traverses Kenya Colony from north to south between longitudes 35° 30′ E. and 36° 40′ E.; this portion is shown by cross-hatching on the index map which accompanies this paper, in its relation to the remainder of the trough. It will be observed from the sketch-map on the scale of 1/200,000,

that the part of Kenya Colony under special consideration in this paper is bounded by latitudes 1° 10′ S. and 1° 30′ S., and by longitudes 36° 25′ E. and 37° 5′ E., and includes the town of Nairobi. In area it is about 1070 square miles, of which 430 miles may be regarded as being within the tectonic zone of the Rift Valley (here called the "fractured zone"), and 640 square miles outside that zone in the undisturbed country (here designated the "undisturbed zone") bordering the trough above its eastern flank. The east-to-west section FF in latitude 1° 24′ S. shows, in conjunction with the index map, the features of the western flank of the trough in their relation to those of the eastern portion. In the preparation of the sketch-map, which depicts in outline the topography and geology of the Nairobi district, reliance has been placed on the topographical data shown on sheet South A 37/GH of the survey of Eastern Africa in so far as that sheet covers the area. In respect of the portion outside the boundaries of that sheet, the map is based on plane-table and 3-inch theodolite surveys, and on compass and Abney level traverses in different portions. Its precision is therefore limited by the degree of accuracy obtained by those methods.

The use of the term "undisturbed zone" is not intended to convey the impression that the regions of Kenya Colony outside the actual trough are regarded as having been free from earth-movements associated with those which affected the trough. On the contrary, the physiography of the whole of Eastern Africa has probably been profoundly influenced by the causes which gave rise to and maintained the Rift Valley trough. In Tanganyika Territory they have expressed themselves in a number of subsidiary fracture lines (Krenkel, 'Die Bruchzonen Ostafrikas,' 1922) and in Kenya by vulcanism along similar subsidiary lines of weakness. The term "undisturbed zone" is used only in the sense that the particular area has not yielded in the manner, and to the degree, that the fractured zone has yielded. No precise line of demarcation between the undisturbed and fractured zones can be drawn; for, although the differences in the topography and structure of the two zones are usually profound, the higher rainfall of the undisturbed zone—a rainfall which encroaches on the fractured zone—has caused the surface features of the portion of the fractured zone adjacent to the junction to be partly obliterated, and its drainage lines captured by those of the undisturbed zone. The approximate line of junction is indicated on the sketch-map, where it is annotated "Approximate Boundary of Fractured Zone." In the Nairobi District, the trough is not bounded by a high steep cliff, as in some of the Rift troughs, but the flank descends to the lowest level by a series of steps, many of which however trend upwards.

The outlines of the physiography of the undisturbed zone, although comparatively simple and usual in type, will now be briefly described in order to make the relationship between the two zones clearer.

The region comprising the undisturbed zone may be described as a

plateau sloping to the east and south-east from levels between 6500 and 7500 feet above sea-level at an average gradient of about 1 in 57 to a level of about 4500 feet at the Athi River. The gradients are usually greater than the average in the higher portion to the west and north-west, and flatter in the eastern half. Except in the south-east of the district, where the ancient crystalline rocks outcrop from beneath the volcanic series, the whole of the region is composed of volcanic rocks having generally a prevailing dip in the same direction as the sloping plateau. The plateau is dissected, in some cases deeply, by numerous streams having the same general directions of slope as the plateau, which is itself consequential on the prevailing dip of the volcanic rocks which compose it. All the surface discharge from these streams, many of which are seasonal, is collected by the Athi River, here flowing in a north-north-east direction parallel to the strike of the foliation planes of the gneiss ridge of Lukenya which forms the eastern flank of its valley. In consequence the river is one of considerable maturity, which manifests itself in gentle gradients and long flat reaches, in striking contrast to the juvenile attributes of the rapidly flowing streams which characterize its tributaries, consequential upon the dip of the volcanic rocks. The latter, however, vary considerably in degree of maturity in different portions of their courses, according to the extent to which they have been rejuvenated by the extravasation of volcanic rocks, more recent than those over which they originally flowed. The average annual rainfall over the zone may be regarded as varying between 28 inches in the south-eastern sector to 40 inches in the extreme north-west; but, being largely seasonal, and evaporation and absorption being high, the Athi River, the main collector of the surface drainage, carries only a small flow in dry seasons.

The volcanic series in the Nairobi District is divisible into six groups, of which four occur in the undisturbed zone. These groups mark stages in eruptive activity. Each group consists of sheets of lavas and tuffs associated with one another stratigraphically, petrographically, and in chemical composition. Where the streams have cut deeply enough, their valleys reveal the order of deposition and the thickness of component members of groups.

The approximate boundaries of the groups are indicated on the map accompanying this paper; and, for the sake of clearness in a map intended to depict only such of the geological features as are necessary for the consideration of the physiographical features, the delineation of the limits of sub-groups and the separation of lava from tuff have been omitted. Moreover, it is not always possible to determine from available information to which particular group tuffs occurring adjacent to a junction belong. Such tuffs have been included with the groups with which they seem, from their field relations and composition, to be associated.

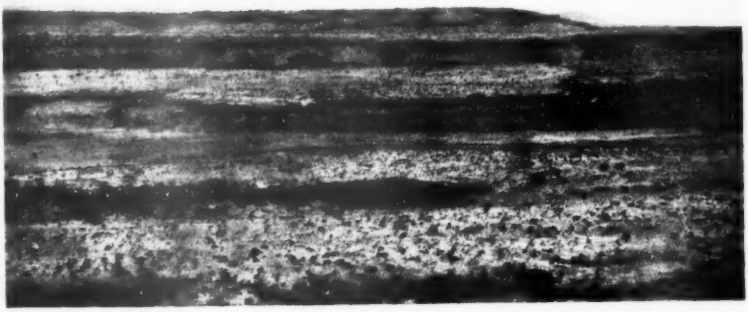
Starting from the south-eastern corner of the Nairobi District, one

finds the ancient crystalline rocks exposed in Lukenya Hill, and in the valleys of the Kitengela and Mbagathi rivers. In the former case the strike of the foliation planes is N. 20° E., while in the latter exposures the strike is practically true north.

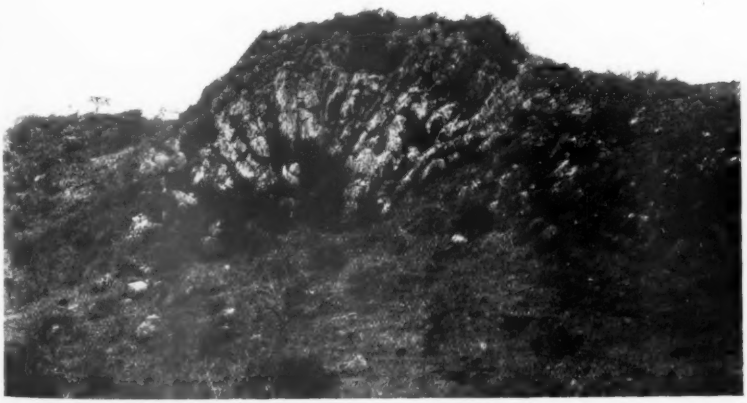
Directly overlying the crystalline rocks the first group of volcanic rocks is exposed. As the observer proceeds in a westward and subsequently in a north-westward direction over the gently rising ground to the boundary with the fractured zone, he encounters in succession the next three groups, each resting on the uppermost component of the group next below in the order of deposition. The easterly limits of the groups are often marked by relatively steep slopes, forming the eroded terminal walls of the more resistant lava sheets composing them, which have flowed from the west or north-west. It is found, in fact, from the stratigraphical sequence as revealed in the valleys, that the major centres of dispersion of the volcanic rocks must have been situated to the westward within the fractured zone, and that the younger groups have a lesser distribution within the undisturbed zone than the older ones, pointing either to a decrease of vulcanism, or the shifting of the main centres of eruption to the westward, or both combined. Although the major vents were situated within the fractured zone (except some of those of the fourth group), a number of subsidiary vents arose within the undisturbed zone on the eastern flanks of the trachytic (Group III.) volcanoes, for there occur at intervals, associated with the major sheets of that group, short streams of a rapidly cooled lava, which was originally glassy, but has now become devitrified by chemical alteration, in contiguity with the products of explosive eruptions.

Individual lava sheets are as a rule attenuated; it is exceptional for a sheet to have a greater thickness than 100 feet. The sheets of lava of any particular group may follow one another directly or have tuff intercalated between them. The proportion of tuff to lava in different groups has not been evaluated. In the volcanic rocks of the first group and, to a much lesser degree, in those of the fourth group, lava is much in excess, and must have been highly liquid on extrusion, spreading fan-like from the centres of eruption over wide areas at flat gradients—a type of vulcanicity more usually associated with flows of basic than of intermediate lavas. A typical example, in the Nairobi District, of this type of vulcanism is the fan-shaped sheet of lava (the upper sub-group of Group I.) which composes the Athi Plains. The exposed portion of this sheet covers an area of 126 square miles, and varies from 100 to 150 feet or more in thickness; it has an average surface gradient in the direction of flow of 1 in 480, which is probably not greatly different from the gradient at which it solidified. The type of vulcanicity which gave rise to the rocks of the remaining groups was much more explosive; for the proportion of tuff and breccia to lava is much higher, and in some cases probably greatly exceeds 50 per cent.

One of the long flat reaches on the Athi River



Typical view of grid of ridges and valleys in Group IV. rocks, looking W.



Fan-shaped arrangement of columns in Group IV. lava of Dome, south of Nadu ridge

Typical view of a valley and scarp of grid, looking N.E.

Sukunuani scarp, looking S.W. Typical of scarps of grid in Group IV. rocks facing E.

One of the wedge-shaped terminations of the N.–S. ridges of the grid in Group IV. rocks, where cut by the Kedong scarp bearing S.S.W.

No palæontological evidence, adequate to enable the age of the volcanic groups to be determined, has so far been forthcoming from the Nairobi District. Lacustrine sediments, sub-aqueous tuff, river alluvia and soils, interbedded between components of the series, are occasionally exposed and have yielded plant remains, but none of those so far procured has proved to be sufficiently limited in time of existence or determinable specifically to permit of the ages of the deposits to be fixed with certainty. Relying on correlative evidence, Professor Gregory ('The Rift Valleys and Geology of East Africa,' pp. 105 and 193–209) has adduced a tentative classification by period of the volcanic rocks of Kenya. According to that classification, the groups of volcanic rocks in the Nairobi District would probably be placed as follows:

Group VI. (trachytes)	Upper Pliocene or Pleistocene.
Group V. (rhyolites and trachytes) ..	Naivashan—Upper or Lower Pliocene.
Group IV. (quartz-trachytes) ..	Upper Laikipian } Lower Pliocene or
Group III. (trachytes)	Middle Laikipian } Upper Miocene.
Group II. (Ngong Basic Series) ..	Lower Laikipian—Miocene.
Group I., sub-group 2 (phonolites) ..	Doinyan—Eocene.
Group I., sub-group 1 (phonolites) ..	Kapitian—Upper Cretaceous.

It is to be hoped that future research in the sediments will yield certain evidence of the age of the groups. It is undoubtedly the case that the oldest volcanic rocks (Kapitian) have suffered greatly from denudation, and that there were varying, and in some cases considerable, lapses of time intervening between the other groups.

Adverting now to the structure of the fractured zone—or eastern flank of the Rift Valley in the Nairobi District—we find topographical features so unusual and so different from those which characterize the undisturbed zone that they would excite the curiosity of the most casual observer. The structure of the fractured zone has many points in common with the adjacent region to the southward, described by Dr. Parkinson in "The East African Trough in the Neighbourhood of the Soda Lakes" (*Geogr. Journ.*, 44, July 1914).

In place of the valleys carved out by erosion in a west-to-east direction along the maximum gradients of an inclined plateau, which carry the surface drainage of the undisturbed zone, there is developed a series of valleys trending in a general north-to-south direction and bounded occasionally by steep cliffs on both sides, but more usually by a steep cliff on one side and a comparatively gentle slope on the other. A type of topography has been produced which is characterized by parallel ridges and valleys following one another in close succession, and which has been called "grid-structure" and "fault-block structure." A traveller from east to west in this district across the trough, in one of its most jagged parts, is impressed by the apparently interminable number of ridges which he has to climb—in section like the teeth of a saw on a gigantic scale—for he has no sooner ascended one cliff and descended a

boulder-strewn slope into the ensuing valley, than he is faced with the ascent of the next cliff. Photographs fail to convey an adequate impression of the succession of long narrow gorges; and sections and maps only enable a partial visualization to be achieved. It is only by ascending to a commanding position, such as the summit of Ol Donyo Nyuki or Najele, when the rising or setting sun illuminates, and causes to stand out in relief, the cliffs of the cañons to the southward, that a full realization of the nature and unusual character of the topography of the valley is conveyed to the mind.

An inspection of the maps and sections will show that in the Nairobi District the rocks exposed in the fractured zone are entirely volcanic, and there is no direct evidence from the district of the level of the underlying ancient crystalline rocks. The highest and lowest points above sea-level in a section from east to west across the eastern flank of the valley are 8070 feet at the summit of Ngong Hill, and 3550 feet at the southern exit from the Enkobirri Gorge—that is a maximum difference of elevation of about 4500 feet in 13 miles, or an average maximum gradient of 6½ per cent. from east to west. Other parts of the flank in the Nairobi District have gradients between that figure and 5 per cent. The average slope of the bottom of the valley approximately from north to south, along the Uaso Kedong, Barajai, and Enkobirri Gorges, is about 1½ per cent. It will be seen that the eastern flank of the Rift Valley in this district—and indeed the western flank also, as shown by Section FF—is of a very different character from that of most of the major troughs of the Rift Valley System, where vulcanism either has not manifested itself, or has been of minor importance; for one finds the flank composed of a "grid" of small parallel ridges and valleys, which have been designated "miniature rift valleys," in place of flat-floored depressions, confined within two boundary walls, as in the case of the Nyasa, Tanganyika, Albert and Edward depressions.

As the eastern flank is traversed from east to west in the descent to lower levels, the climate is found to become drier; the well-watered, soil-covered slopes of the undisturbed zone, with their grass lands, forests, and cultivation, give place to cliffs and boulder-strewn slopes, scantily clothed with thorn-scrub and isolated grass tufts, in a semi-arid climate. The valleys contain no permanently flowing water, and only one permanent waterhole, namely Enkobirri, exists in a distance of 40 miles between the springs of Ngong Hill on the eastern side and the Uaso Nyiro River on the western side of the valley. Humid air, drifting from the eastward with the prevailing winds, is cooled as it ascends the inclined plateau of the undisturbed zone, parting with most of its moisture; it then encounters the heated air rising from the valley and the rain-clouds become absorbed. Much of the rainfall within the valley is discharged during thunderstorms. Although considerable local precipitation then takes place, it is rapidly removed from the surface by soakage into the

warm thirsty soil, and most of it must be subsequently evaporated under intense solar heat.

In the strip of country delimited to the east by the boundary with the undisturbed zone, there is encroachment by the meteorological conditions of the undisturbed zone, which has registered itself on the topographical and hydrographical features of the strip; for, although many of the drainage lines follow, for portions of their courses, the north-to-south valleys, much flattened by denudation, they have been captured by the progressive erosion of the streams of the undisturbed zone.

Turning now to the formations comprising the fractured zone, it will be seen (*vide* map) that the first and third groups of the volcanic series only just encroach on the area, as they have been overwhelmed by more recent groups in this district. Group II. (Ngong Basic Series) is only represented in Ngong Hill and the country near it, while Group IV. covers most of the zone. As will be observed from Section FF, rocks of the fourth group form the opposite western flank of the Rift Valley, with the exception of a narrow stream of lava belonging to the fifth group. The Group V. series occurs only in the Kedong Valley and the region to the westward adjacent to it; it is succeeded by the sixth group, which comprises the comparatively recent products of eruption from the volcano called Ol Doinyo Nyuki and vents associated with it.

Considering first the country covered by the fourth group of volcanic rocks, it is found that it is built up of a succession of comparatively thin sheets of lava—tuff being practically absent, although well developed in the region to the north-east outside the Nairobi District. To the south, the exposures of this group terminate against the Ngong scarp and the slopes of Ol Esayeti and Ol Oigululu, which are formed of the older Group II. series. Fifteen miles to the north, the grid of closely packed ridges and valleys which form the intervening country sloping gently downward to the south, is cut off abruptly by the Kedong cross-fault which, trending in a south-westerly direction, has given the ridges of the grid sharply angular terminations above the south end of the Kedong basin. It will be observed from the map that the Kedong Escarpment swings to a northerly direction, where it bounds the Kedong basin on its eastern side, and that above the scarp the ridges and valleys of the eastern portion of the grid continue at the same slight general upward slope to the northward. Below the escarpment, however, on the eastern flank of the Kedong basin, the grid of Group IV. rocks reappears at a much lower level, but partially obscured by those of the fifth group. The portion of the Kedong scarp, trending northward parallel to the major structural lines of the Rift Valley, persists for some 10 miles beyond the northern limit of the map (lat. 1° 10′ S.) in the same group of volcanic rocks. The portion trending to the south-west also continues in that direction beyond the western limit of the map (long. 36° 25′ E.) for several miles, though with less prominent

topographical features; here it continues to cut off the southward-sloping ridges of Group IV. rocks from extension to the northward in a series of less prominent but occasionally steep slopes. A homologous transverse structural line, though not in continuation of that on the eastern flank, may be traced on the western flank of the Rift Valley.

The evidence indicates that many of the major centres of eruption from which the lavas of the grid emanated were situated to the north of this transverse tectonic line, and the original direction of flow of many of the large lava sheets of the fractured zone was between southward and south-westward. In the undisturbed zone, as mentioned above, the general dip is between south-east and east. In the highland to the north of the Nairobi District, rising to elevations between 7500 and 8500 feet, in the neighbourhood of, and east of, Limoru, Escarpment, and Kijabe, the Group IV. series is thick and is largely composed in its upper portion of tuff, pointing to the termination of the period of Group IV. vulcanism in explosive eruptions. The former extension of these highlands in a westerly direction is now cut off by the Kedong scarp. The conclusion is forced upon one that this western extension, comprising some of the major centres of dispersion and occupying the site of the Kedong Valley and the recent volcano, Ol Doinyo Nyuki, has subsided along the lines of the Kedong main fault and Kedong cross fault; its site is now occupied by the products of later eruptions and by lake sediments of Upper Pliocene or Lower Pleistocene age.

The final eruptions seem to have been explosive in type, but much of the lava was probably extruded quietly through vents producing flat domes. Small dome-shaped masses in the higher elevations of the fractured zone, on some of the ridges trending north and south, are possibly vents of this nature. Where cut in section by a scarp, a dome often discloses a series of contraction columns of lava, arranged like a fan, which appears to indicate that the isothermal surfaces, during cooling, had the form of the existing surface of the dome, the columns developing at right angles to those surfaces.

The evidence in the Kedong Valley seems to point to the collapse along the Kedong main and cross faults having followed the Group V. eruptions. The rocks of that group contain an extensive series of tuffs associated with the lavas. Cauldron subsidences, analogous to subsidences of this kind, have occurred in Ol Doinyo Nyuki volcano, Menengai, and other large comparatively recent centres of eruption. These may be regarded as still progressing. Such collapse might be expected to occur in a region of tension, as cooling and shrinkage of the extruded and subjacent material takes place; it would be greatest where the maximum accumulation of ejecta exists, that is, in the region of the vents.

The homologous course of events, which a study of the much older volcanic rocks of the second group reveals on the western side of Ngong Hill in their relationship with the southern ends of the flows of the

Group IV. series of lavas, will now be referred to. It will be seen from the map and section CC that Ngong Hill (8074 feet) is a ridge in the Group II. series, trending slightly to the west of north for about 8 miles, composed of basic tuff and breccia with interbedded sheets and streams of basic lava, having generally an eastward dip. The steepest slope is on the western side of the ridge at an average angle of about 25°, the scarp having been greatly eroded. The same group of volcanic rocks extends in a westerly direction, from the south end of Ngong Hill, as a bastion comprising the mountains of Ol Esayeti and Ol Oigululu; while its southward extension forms the Doinyo Narok Hills, which are cut off westward by the Kapiti Scarp for 18 miles, where rocks of the first group appear from beneath them. The relationship between the Group IV. series and the Group II. series is clearly revealed in the gorges, which have been eroded through the former into the latter. Here, prior to the extrusion of the Group IV. lavas, the former highlands comprising the major centres of dispersion of the Group II. series were downthrown along the Ngong main fault and Ngong cross fault, forming a basin into which the lavas of the fourth group subsequently flowed from the northward. It is clear that the formation of the basin occurred in the region where the volcanic ejecta of the second group of vulcanism was accumulated to its greatest thickness—namely over the vents which gave rise to it, in the same way, and from the same cause, that the formation of the Kedong Basin succeeded the extrusion of the fourth and fifth groups. Although definite evidence to show that subsidence followed the extravasation of the third group of volcanic rocks is not forthcoming from the Nairobi District, the extent and position of the exposures of that group and their relationship with those of the fourth group render it probable that subsidence occurred before the lavas of the fourth group overwhelmed the sites of their vents from the northward. In other districts, evidence is strong that periods of intense vulcanism on the flanks of the Rift Valley were followed by periods of subsidence of the regions comprising the vents, before the next major period of vulcanism occurred.

The evidence from the Nairobi District regarding the origin of the grids of north and south ridges and the relation of their structural lines to those of the Rift Valley will now be considered. The region in this district which portrays the structure of the grids to the best advantage is that composed of Group IV. rocks, especially that west of long. 36° 33′, and including the titled blocks referred to by Professor Gregory as "Cathedral Hill" (*i.e.* Najele) and the "Cathedral Bastion" ('The Rift Valleys and Geology of East Africa,' p. 214). One naturally turns to the Kedong cross fault where the north-to-south ridges and valleys are cut off by a portion of the Kedong scarp for evidence of meridional faulting, for the scarp has sectioned the ridges and valleys of the grid to depths of some hundreds of feet below the bottoms of its valleys

Unfortunately, although the edges of the sheets of lava are clearly shown in the higher elevations of the cliffs, the lower levels are much obscured by screes. Examination of the steeply sloping and sinuous gorges carrying the discharge down the escarpment from the adjacent summits of the floors of the long southward-sloping valleys of the grid, has failed to reveal meridional faults with throws up to 400 feet. If the walls of the valleys of the grid were formed by faults having throws comparable with their heights, one would expect to find evidence of it at this locality. Minor gravity faults, with throws up to 50 feet, are not infrequent, but are often not in continuation of the cliff faces of the grid. The tilting of the blocks, so that the resolved components of the dips of their lava sheets in a westerly direction now varies from 1° to 10°, is undoubtedly the result of fracture and bending, of the nature of gravity faulting along north-south planes of weakness, but the movements seem inadequate to account completely for the present form and depth of the deeper valleys. Nor could evidence be found on the face of the escarpment of trough faulting, which might otherwise account for these deeper valleys. In other parts of the Rift Valley flank, cross valleys show gravity faults of considerable throw, striking north and south, while small ones are frequent ; but, in the case of the majority of the deeper valleys of the grids, the writer is of the opinion that the evidence indicates that they have been initiated and partly developed by gravity faulting and jointing, and that they have been deepened and widened by erosion.

Before considering the evidences of erosion and its extent, it is necessary to examine the causes which may have influenced the development of the north-south gravity faults, which appear to follow one another in close succession and to give direction to the ridges and valley lines of the grid. It will have been seen that the Group IV. lavas have been spread over series of older groups, and it is obvious from examination of places where these older rocks are exposed in the Rift Valley that grid structure has generally been developed in them also. A sheet of lava, on coming to rest over a series of parallel valleys, would be likely to develop a dominating series of contraction joints parallel to the valleys. Although the directions of jointing, and its form, vary greatly in the rocks of the grid, it is sometimes the case that a set of joints clearly follows a north-and-south direction for a considerable distance, and persists in exposures in cross valleys. Similar joints may even be observed in tuffs, and erosion along them sometimes produces closely packed miniature clefts, similar on a small scale to the miniature rift valleys of the grid.

The total volumetric contraction of rock material of different kinds in passing from a molten to a crystalline state and in cooling to atmospheric temperature is considerable in all ordinary cases, but uncertain in quantity. In the case of a lava extruded on the surface, the change of

volume would depend greatly on the chemical composition, water content, temperature on coming to rest, the extent to which pre-crystallization had taken place, and other factors. Probably the most reliable evaluation of the volumetric change of basic rocks is that determined from the experiments of Day, Sosman, and Hostetter (*Amer. Journ. of Science*, **37**, 1914, 1–39), which indicate an expansion of 10 per cent. in volume in passing from the crystalline to the vitreous state. Evidence regarding the acid and intermediate rocks seems less certain. If the average linear contraction of the intermediate soda-rich lavas of Kenya is taken as 3 per cent., the total horizontal contraction, distributed over a vast number of minute openings in a sheet 15 miles wide, would be nearly half a mile, while the vertical contraction in a series of sheets 2500 feet thick would be 75 feet.

In his presidential address to the Geological Society (*Quart. Journ. Geol. Soc.*, vol. 81, July 1925), Dr. Evans has drawn attention to the close relationship between slip faulting and jointing in a region of tension. It would seem that something more than regional east-west tension is required to give meridional direction to the closely spaced parallel gravity faults in the masses of volcanic rock composing the grid; for otherwise they would be likely to be much more irregular in direction than they actually are, and sunk-lands without definite direction of boundary would be formed. If a slab of concrete were subjected to tension and fractured, increased tension would merely make it open further at that crack, though in the case of reinforced concrete it has been shown by experiment that yield takes place in the form of a large number of minute openings. It is thought that this guiding direction and the occurrence of such a large number of parallel fractures may have been caused by the dominating set of joint planes and vertical slip along them as the lavas contracted. There is a general tendency for the depths of the valleys of a grid to be greatest where the accumulation of material of the particular group is greatest. Each group has to a very large extent its own series of ridges and valleys, although pre-existing eroded scarps in older groups are often rejuvenated by the subsequent series of faults appurtenant to the newer group, especially in parts where the movement of the newer group has been large. Generally, however, when only the thin terminal portions of the flows of a new group transgress an old one, rejuvenation does not occur, owing to the small thickness of matter superimposed on the old group. This is illustrated in the fractured zone of the Nairobi District, where lavas of the fourth group, flowing from north to south, have transgressed the Group II. series on the northern slope of Ol Esayeti Hill, without transmitting the faulting induced in them to that hill. In fact, the sheets of lava sag northward for the first 3 miles from their termination, so that their downward gradient is now northward to the extent of about 100 feet in that distance. Dykes are seldom to be observed in the

fractured zone. A few narrow ones have been noted on the Ngong scarp, where they traverse basic tuff nearly vertically. There are several in the Barajai Gorge composed of the same lava as the Group VI. rocks which they traverse. Where dykes occur, they seem to tend to follow lines of conjugate weakness in preference to the main lines, or it may be that they are more evident when they do so than when they follow the main lines.

The effects of denudation in the fractured zone will now be briefly referred to. As already mentioned, the present climate of the lower levels of the fractured zone is semi-arid. The natural main line of drainage is through the Kedong basin, the Barajai Gorge, and the Enkobirri Gorge. The channel of the Kedong River occupies the Kedong basin, and during wet seasons the stream flows through the Barajai Gorge and reaches the northern end of the Enkobirri Gorge, before it is completely lost by absorption and evaporation. In the dry season the flow in the Kedong River, usually amounting to rather over a cubic foot per second, emanates chiefly from springs at the foot of the Kedong scarp, and generally fails to reach the north end of Najele Hill. No flood channel exists as a surface feature in the Enkobirri Gorge, except occasionally where one has been formed by the flood discharge from a cross valley for a short distance. A continuous down grade, however, exists from the watershed line, 150 feet above Lake Naivasha in the Njorowa Gorge (' The Rift Valleys and Geology of East Africa,' Gregory, 1921, p. 168), through the Njorowa Gorge, over the Suswa plains, through the Kedong basin, the Barajai and Enkobirri Gorges, and eventually to the Kura plains in the neighbourhood of Lake Magadi (*vide* "The East African Trough in the Neighbourhood of the Soda Lakes," Parkinson, *Geogr. Journ.*, July 1914, pp. 41, 42). This line of drainage carried a large discharge in Lower Pleistocene time, for its valley is floored and flanked by lake and river sediments throughout much of its course, indicating a succession of lakes chiefly fed by the discharge from the larger and deeper Lake Naivasha of that time. Some of the sediments are older than the volcanic rocks of the sixth group. The southern portion of the Kedong basin contained one of these lakes, and its sediments yield water-worn pebbles of a kind of lava (comendite), which is not known to occur *in situ* nearer than the hills south of Lake Naivasha, where they are traversed by the Njorowa Gorge. The Barajai Gorge is the homologue of the Njorowa Gorge. It is flanked by cliffs usually varying from 200 feet to 400 feet in height, but in the case of one scarp rising to over 700 feet. It will be observed from the map that the course of the Kedong River, flowing in a south-south-west direction along the foot of a steep scarp in Group VI. lava, is deflected to the west at the northern foot of Najele Hill and follows a westerly course for 2 miles along a plane of weakness, probably engendered by conjugate jointing and slip faulting ; it then meets one of the meridional fracture lines and

Embarabal-o-Saidal scarp from N.W. Ngong hill scarp in distance

A cross valley entering Enkobirri gorge from the west

A N.–S. fault where cut by a cross valley. From floor of cross valley looking N.E.

Enkobirri gorge looking S.W., Lacustrine sediments in foreground and middle distance

Barajai scarp and gorge, looking south

Lake sediments at Kichero in the Kedong Basin, looking E. Kedong main scarp in background

follows it for a mile, when it is again deflected along a short cross valley to the Enkobirri Gorge. The Barajai Gorge and much of the Enkobirri Gorge appear to have been eroded in Lower Pleistocene time, but previously the discharge from the northward flowed along different lines at higher levels; for the remains of sediments, terraces, and water-eroded rocks indicate that, prior to the formation of the Barajai Gorge, the main line of drainage followed, at different times, adjacent meridional valleys having floors several hundred feet higher than that of the existing Barajai Gorge. One of these was the valley east of Najele Hill, and another the valley east of Tiridik.

Prior to the subsidence of the higher elevations, within the Rift Valley, of the volcanic rocks of the fourth group, along the lines of the Kedong main and cross faults, but subsequent to the development of the structure of the existing grid, the southern discharge from these higher elevations must have been carried down the parallel valleys of the grid, widening and deepening them. Vestiges of river terraces, although largely obliterated and rearranged by wind action in a semi-arid climate, exist; and the occurrence of water-worn pebbles of a type of lava similar to one which occurs in the Aberdare Range, which bounds the Rift Valley 40 miles to the northward, indicates the possibility of the drainage from the southern end of the western flank of that range having then been carried into the Rift Valley, instead of away from it as at present. Much of the earlier discharge of the higher levels of the eastern flank of the Rift Valley must have been conveyed past Naironde, west of Ngong Hill, through the deep valley of Ol Keju Lolosogwen, to the plains of Ladariak, west of the Kapiti scarp. Some of it, however, seems to have terminated in enclosed lakes and swamps within the Nairobi District.

The intense precipitation which occurred in East Africa during Lower Pleistocene and earlier times, when lakes, now dried up, existed and existing lakes were much extended, has been referred to by numerous writers, notably, in respect of Kenya Colony, by Gregory, Hobley, and Parkinson. During this period the glaciation of Kenya Mountain extended to 4500 feet below its present level. In the Athi River Valley, within the undisturbed zone of the Nairobi District, one or more shallow lakes of considerable extent existed, the sediments of which are indicated on the map accompanying this paper. Mr. C. E. P. Brooks has shown (*Quart. Journ. Met. Soc.*, vol. 40, 1914) that high rainfall in the tropics during the Glacial Period was a necessary consequence of the large polar anticyclones of that period.

It will be seen that the parallel valleys of the grid-structure are regarded as having been initiated, and given direction, by gravity faulting and jointing in a region of east-west tension, and as having been widened and deepened by erosion. Their lower parts are frequently found to be partly filled, or levelled off, by a wind-carried loess-like loam (Maufe, "Report relating to the Geology of the East Africa Protectorate," 1908).

The steepness of the upper levels of the scarps of the valleys seems often to be due to exfoliation, the products of which collect at lower levels of the scarps as screes at comparatively gentle slopes. This exfoliation is helped by the vertical joint planes. It is very difficult to form an opinion as to how much of the existing form of the valleys is due to each cause. In the case of the Enkobirri Gorge, the final act of erosion through pre-existing sediments appears to have deepened the gorge by about 135 feet. As mentioned by Thiele and Wilson, when considering the relation between the tectonic and physiographic features of the Rift Valley zone south of the Zambesi (" Portuguese East Africa between the Zambesi River and the Sabi River," *Geogr. Journ.*, **45**, 1915), " There is no doubt that many important surface features have been largely determined by earth-movements, but it is not always easy to decide what share is due to tectonic forces, and how much should be attributed to general erosion, guided and influenced by rock texture and structure." In treating of the Nyasa trough, Andrew and Bailey (*Quart. Journ. Geol. Soc.*, **60**, p. 233) indicate the partial fashioning of the trough in its present form by forces other than earth-movement.

In common with most of the volcanic rocks of Kenya Colony, other than the pre-Rift Valley series in the west of the Colony (Oswald, " Miocene Beds of the Victoria Nyanza," *Quart. Journ. Geol. Soc.*, 1914) and lavas in the north of the colony (Parkinson, *Abst. Proc. Geol. Soc.*, 1915), all are characterized by richness in soda and generally by extreme poverty in lime and magnesia. In respect of silica content, typical specimens from the groups show, on analysis by Mr. Colet Birch, Government Analyst, Kenya Colony, the following percentages : I. (sub-group 1), 54·00 ; I. (sub-group 2), 56·70 ; II., 46·34 ; III., 57·53 ; IV., 66·34 ; V., 70·30. The chemical composition of the lowest component of Group I. may be regarded as representative of the primitive soda-rich magma of intermediate acidity which on extrusion produced extensive plateaux, immediately overlying the ancient crystalline rocks, which form the basement of Kenya Colony. In composition it is very similar to that of the plutonic plug (nepheline syenite) of Kenya Mountain. It would therefore appear that the original soda-rich magma, having a silica percentage of 54, as represented by the lowest member of Group I. lavas, became differentiated, and in subsequent eruptions in the district, from closely adjacent vents, gave rise to products having silica percentages of 70 at the acid end and 46 at the basic end of the series.

These circumstances are not without their significance in the consideration of the physiography of the Nairobi District, which is the only justification for reference to them here. They appear to indicate that the original soda-rich lava of Group I., which flooded wide areas in the colony on a scale comparable with the basaltic eruptions of Iceland (Thoroddsen, *Geogr. Journ.*, **13**, 1899), the Deccan and Oregon, were very hot and liquid magmatic eruptions, emanating from a depth, which

may have been the base of the sial, while the subsequent eruptions appear to have been differentiation products of the portion of original magma, which had moved upward. Moreover, the silica percentage of this lava differs by only 4 per cent. from the average of the Atlantic and Pacific magma-basalts analyzed by H. S. Washington (*Bull. Geol. Soc. America*). The initial eruptions produced sheets of lava at gentle gradient, while the subsequent eruptions were generally associated with cones of tuff and the lavas solidified at steeper gradients.

Dr. Evans has advanced a theory (*Nature*, 8 August 1925, p. 212) to explain the origin of soda-rich magmas by the pre-crystallization from the sima of high-pressure minerals rich in magnesia, iron, and lime, resulting in the removal of a large proportion of those constituents from the magma so affected, and consequent richness in soda of the remainder. The not infrequent occurrence of garnet-gneiss in the ancient crystalline rocks of Kenya Colony, which may be altered intrusions in the very old group of metamorphosed sediments, named by Dr. Parkinson the Turoka Series (*Quart. Journ. Geol. Soc.*, 69, pp. 534–539), may not be without significance in this connection. These ancient sediments apparently have a wide distribution in Kenya Colony (Glenday and Parkinson, *Abst. Proc. Geol. Soc.*, 6 January 1926).

The sequence of events in the region of the trough in the Nairobi District during most of Kainozoic time points to the existence of east-west tension which varied periodically in intensity. As pointed out by Sollas, and often reiterated by others, normal faulting in general results from the action of tensile forces. Difficult and controversial though the subject of vulcanism is, the conclusion that the volcanic activity as well as the gravity faulting resulted from crustal tension, however induced, seems unavoidable. Doubtless other causative factors contributed their quota, but it seems inconceivable that periodically recurring vulcanism followed by subsidence along dominant joint planes, having a nearly constant direction, could have occurred while the upper part of the crust in the region of the earth-movements was either under horizontal compression or free from applied force normal to the planes of subsidence. When the intensity of tensile stress became great enough, yield would express itself by liquefaction of rock at depth and extrusion at the surface, on account of expansion on fusion and release of gases. As cooling progressed after relative stability had been attained, the accumulation of mass above and deficiency at depth would cause adjustment by superficial subsidence.

Three main groups of meridional tension faulting, following successively the three periods of major vulcanicity, are recognized by Professor Gregory, and the age of these movements he regards as Oligocene (pre-Nyasan), Pliocene (Naivasha), and Pleistocene. The principle that transverse movements in conjunction with rejuvenation of the old meridional fracture planes caused the basins of the Rift Valley in Kenya

is also enunciated by him ('The Rift Valleys and Geology of East Africa,' 1921, p. 216). The evidence from the Nairobi District points to four or possibly five major movements having followed periods of vulcanicity, but these movements were comparatively local and largely confined to the rocks produced by the period of vulcanicity, which they followed. Investigation has failed to yield any evidence in the district of transverse folding amongst the volcanic rocks. Regional pressure in all directions seems to have been absent throughout. The not infrequent gentle reversals of dip in sheets of lava, often accompanied by slip faulting, which are clearly shown on north-south cliff faces, are regarded by the writer as having been caused partly by self-adjusting movements in the sheets of volcanic material as they cooled, contracted, and sank unequally, and partly by deposition over oppositely sloping surfaces. The movements along the major cross faults also show no evidence of north-south compression; on the contrary, they point to its absence.

Most investigators have regarded the East African troughs as having been caused by tensile stress, but a few have urged the greater probability of their origin as structural features by compression, notably Mr. Wayland, Director of Geological Survey, Uganda (*Geogr. Journ.*, November 1921), as a result of his investigation of the Albertine trough between Uganda and the Congo. Mr. Wayland also concludes ('Petroleum in Uganda,' Appendix A, 1925) that compression caused movements in the Lake Albert trough from the Oligocene to the Middle Pleistocene. If this conclusion is correct it would appear that the Eastern Rift Valley was subject to tension and the Western Rift Valley to compression during Kainozoic time. It is to be observed, also, that Krenkel ('Die Bruchzonen Ostafrikas,' 1922) and other German writers have found the faults of the troughs in Tanganyika Territory to be normal ones, and therefore tensional, while the results of the gravity survey of Kohlschütter conform with this view. It is conceivable that the formation of the Rift Valleys as structural features antedated the first eruptions; in fact, where unrejuvenated flanks of the valley in Kenya are composed of ancient metamorphic rocks, they are generally gentle slopes more deeply eroded even than the earliest lavas. No evidence pointing to its original development as a structural feature by compression causing reversed faulting and overthrusting has, however, so far been adduced in the case of the Kenya trough.

A study of the physiography of a very small section of the Rift Valley system without correlation with that of other parts is necessarily inadequate to justify any attempt being made in this paper to examine the theories which have been advanced to account for the stresses which gave rise to the East African Rift Valleys. The theory advanced by Professor Gregory, based on the doming of Eastern Africa and the subsidence of the Indian Ocean, with effect from the Cretaceous to the

Oligocene and the wrench caused by the Eurasian mountain-building movements between the Oligocene and the Pliocene (*Geogr. Journ.*, 1920) is well known. A new light has been thrown on the difficult subject of crustal tension by Professor Joly (' The Surface History of the Earth,' 1925, and two earlier publications). Much additional data, together with mathematical treatment on the lines adopted by Dr. Jeffreys (' The Earth,' 1924), seem necessary before any individual theory of the origin of Rift Valleys commands general acceptance.

The writer considers that the evidence so far noted in the Nairobi District, and adjacent districts, leads to the following summarized conclusions with regard to the Nairobi District :

(1) The earliest eruptions were of the " massive " type and representative of the original magma. Subsequent eruptions were products of differentiation of the original magma and were largely of the explosive type. The major centres of eruption were situated within the fractured zone.

(2) The volcanic rocks are divisible into six groups, each marking a period of volcanic activity and followed by a period of comparative quiescence.

(3) From the earliest manifestations of vulcanism, the Rift Valley has been in a state of regional east-west tension without conjugate north-south compression.

(4) Following each period of vulcanism, as represented by the corresponding group, gravity or slip faulting took place along many closely spaced planes of weakness directed approximately meridionally, giving rise to the " grid " or " fault block " structure.

(5) Meridional direction was given to the succession of closely spaced planes of subsidence by (*a*) the dominating series of contraction joints being developed in each group parallel to the scarps of pre-existing grids ; and (*b*) maximum vertical contraction of lavas taking place in and over the pre-existing valleys of those earlier grids. These factors initiated the parallel lines of weakness along which subsequent gravity faulting took place, by reason of the continuous east-west tension.

(6) The faulting following the extrusion of a group was chiefly confined to the material erupted during that period of vulcanism, the older groups having acquired relative stability. The throw of the faults was greatest where the mass extruded was greatest.

(7) The major centres of activity of each group within the fractured zone subsided along cross faults, and the pre-existing meridional main faults, which were thereby rejuvenated. The result was the production of basins in place of highlands formed of the greatest mass of material. The cause of subsidence was the accumulation of material over the surface and consequent deficiency at depth in the area where the major centres of eruption existed, in a region of continuously operating tension. These

basins were subsequently overwhelmed by later products of eruption on recrudescence of vulcanism.

(8) The present form of the "miniature rift valleys" of the grid is largely due to erosion of the valleys which had been initiated and partly developed by jointing and faulting.

THE GROUPING OF FORMS IN NATURAL SCENERY

Vaughan Cornish, D.Sc.

Read in abstract at the Oxford Meeting of the British Association (1926) in Section E (Geography).

1. **HARMONY and Disharmony in Nature.**—Men of science have studied the structural forms of Natural Scenery in detail but have given relatively little attention to their apparent grouping, upon which the beauty of Landscape largely depends.* Neither can we learn the condition of harmonious grouping in Natural Landscape from the landscape painters, for even those who believe in being "true to Nature," in the sense of following natural forms, do not "copy Nature" in the sense of accepting the grouping of forms which confronts them in the landscape. The reason for re-arrangement, or "composition," has not only to do with the material restrictions of painting but with the fundamental fact that disharmonies of form occur in purely Natural Scenery, and that it is only when and where there happens to be a broad angle of outlook free from an intrusive disharmony that the eye finds perfect satisfaction in the landscape. The opinion of many Nature-lovers that the appearance of purely natural surroundings is always harmonious is largely due to the cooperation of the senses. Fresh air and fragrance, the song of birds and the rustle of the leaves, crisp cold, balmy warmth, and the salt sea breeze all play their part and help to make us more than satisfied with what we see. To point out visual disharmonies to the contented Nature-lover seems an ungrateful task, but has its use, for there are beautiful relations of earth and sky, of land and sea, of tree and mountain, there are broad effects and subtle effects, which will never be fully appreciated unless the conditions of visual harmony are critically studied.

2. **Land and Cloud.**—Tradition apart, there are conditions when the heaven actually appears as a vault or dome. A hill overlooking the lowlands of Southern England with a broadly stretching sky-line of treeless downs 20 miles away sometimes provides such a picture when detached clouds dot the sky. The beauty of the scene is more than the

* The forms of the land are comprehensively described in 'The Scientific Study of Scenery,' by Dr. J. E. Marr.

beauty of its two parts. The satisfaction which it gives is not merely due to the pleasure of a panorama of the plain and the pleasure of an uninterrupted view of the clouds, but to the harmonious combination of land and sky. I made sure of this conclusion when out on Old Dean Common near Camberley, with a broad view westwards to the distant downs of Hampshire and Berkshire on a summer day of blue sky and drifting white cloud. The top of the common is a level plateau covered with short heath, and my standpoint was 100 yards back from its horizontal edge. Reclining on my side, I adjusted the height of the eye so that the edge of the plateau just covered the distant downs. Although no part of the sky was cut off, the vault was no longer vast in appearance. On standing again erect, the vault, seen as the roof of a wide instead of a narrow world, regained its grandeur. I noticed that the detached white clouds overhead were not drawn down by the extension of the rim of sky as might have been expected, the camber of the arch remaining bold. The impression of the vault is enhanced by the completion of the panorama from an isolated eminence, such as the Cairn on the hill above Llandrindod, with its wide view of Central Wales. I find that from this point the eye can take in only one-sixth part of the encirclement of hills at once, from which it may be safely inferred that the full effect of the vaulted roof is obtained by a mental synthesis of separate views.

Cumulus, the cloud of pre-eminent form, rises from a flat base, and at any given time the bases are at about the same altitude. We know these clouds to be the white caps of great billows of air, but, beautiful as this scientific conception is, the natural man within us delights most in those views in which the pile of clustered domes does not appear suspended, but rises from misty shadow so as to produce the perfect illusion of a range of lofty mountains. Towards the close of a fine summer day I noticed a range of cumulus above the northern horizon which, except for the difference between domes and pyramids, reminded me of the Bernese Alps as seen from Oberhofen, on the lake of Thun (where the Mönch stands up more than 6°), and I found on measurement that the summits of the clouds were 7° above the level of the eye.

Cumulus in numerous detached portions has a remarkable perspective grouping towards the horizon. This grouping shows best at sea, where the strong level sky-line imparts unity to the clouds, whose level bases are narrowed by perspective. This picture is seen to perfection near the northern edge of the Trade Winds on the voyage to the West Indies, where the sea horizon is frequently very clear.

Trees, which often combine effectively with clear sky, spoil the view of cumulus, for they neither allow the perspective arrangement to be well seen nor make a pattern with bright masses which show through the perforated screen of foliage. Individual cumulus clouds standing somewhat high in the sky, and therefore fairly near, often subtend so large an angle that they will only group with a landscape free from

small detail, unenclosed and untimbered, since there is not sufficient similarity of appearance to give the impression of repetition in miniature. The harmony is best where the relief of the land is that of bold, smooth curves, as in the Chalk Downs and the green hills of Central Wales. From the Cairn on the isolated ridge above Llandrindod, at a height of about 1150 feet, there is a complete panorama of higher hills beyond the encircling valley, many of them entirely free from fences and most of them with smooth grassy summits. During unsettled weather in the month of August, with great massive clouds, the whole environment above and below the sky-line combined in a pattern of salient, rounded masses. The scene was truly grand, in a way not, I believe, to be matched in the high Alps. This is partly owing to the sharp forms of the Alps and partly to their linear altitude, for it happens that the base-level of the massive clouds is usually below that of the high Alpine peaks and above that of the mountains of Great Britain. In the season at Llandrindod to which I have referred the hills were sometimes seen against blue sky and sometimes against a background of uniform cloud. Then the eye followed the crest-line of the hills, which, although not actually monotonous, has only a weak rhythm much inferior to that of the crest-line of an Alpine range. When the clouds were detached and massive the range of the eye was vertical, and there was a strong rhythm, not of lines, but salient masses.

Whenever the conditions of form and tone unite the world above and below the sky-line in one pattern, the scenery takes on a look of grandeur. Such a combination is achieved in the Fen Country when a cone of broad rays—Jacob's ladders—rising towards a high sun screened among clouds, forms a steep and lofty pyramid, complete with the low level horizon as base. The great pyramid of Cheops itself gives no such impression of loftiness as this accidental structure of luminous lines in a region where we should least expect to be thrilled by the sense of height.

At Bournemouth, when the first stage of a cyclonic depression passes, the pall of low cloud, accompanied by fine rain and muggy air, breaks up as the wind veers from south-west to north-west, the air clears, and the sky hardens. The wind, now off-shore, meets the breakers, driving the white foam backwards from their crests, and patches of ruffled water mark the gusts which swirl down from the cliffs. Great white clouds sail across the sky, their attendant shadows on the water travelling away in purple patches towards the level horizon. Form and movement above and below are harmonious, cloud and shadow enhancing one another, but the rhythm of the shadows is the stronger, for their narrowing by perspective is more rapid. Thus, whilst the purple shadows near the shore are broad ovals not very different in shape from the clouds above, the shadows farther out coalesce in narrow bands parallel to the horizon.

When clouds send shadows chasing across the open spaces of rolling downs the rhythm of movement is delightful, but the inequality of the

ground distorts the shapes. There are, on the other hand, occasions when a land-form accurately shadowed on cloud produces a visual grouping of a very striking kind. I have not happened to see from a mountain-top the spectre of the mountain thrown upon mist, and I do not attempt to deal with the æsthetics of that which I have not experienced, but when dwelling in the valley I have seen the phantom of a mountain suddenly appear in the clouds, an amazing reproduction of a familiar form on a preternatural scale. This was in the month of July, when I was staying at Grindelwald. The Wetterhorn, 4 miles distant horizontally and rising more than 20°, stood between us and the rising sun. On the morning of July 16 the wind was north of east, blowing across the mountain towards the village, and a streamer of cloud eddied in the lee of the mountain crest. At twenty minutes past six a mountain of miraculous height, far exceeding the dimensions of the Alps, suddenly appeared in the eastern sky. Its peak, which stood at twice as high an angle as the Vordere Wetterhorn (not directly above but rather to the right), and in the same pictorial plane, *i.e.* apparently at the same horizontal distance, had the same shape of summit with twice the breadth. The dark form of the phantom was not continuous with the dark form of the substantial mountain, a space of light-toned cloud without features intervening, thus giving the phantom a detached appearance similar to that which a real mountain has when rising above the mists. As the sun climbed behind the Wetterhorn the summit of the phantom mountain came down, shifting to the left. At first it descended rapidly, diminishing in breadth the while; afterwards it descended slowly, and at 6.55 a.m. had regained its original breadth, twice that of the real peak. It seems, therefore, that the cloud-screen at first shifted towards the mountain and then away from it, the initial and final position being about halfway between the mountain and the observer.

The banner-cloud, or streamer, which provided this optical phenomenon, illustrates, when seen in profile, a physical process of great interest, which gives rise to a remarkable grouping of forms. The Finsteraarhorn, Eiger, and Matterhorn are cloud-compelling mountains which well display the streaming banner. I vividly recall a day in early June when, leaving Zermatt soon after eight o'clock and taking the road up the valley towards Zmutt, I had the Matterhorn in view during the whole morning. A strong westerly breeze was blowing across the mountain. The north-western face of the steep and lofty pyramid stood out clear and solid, but the south-eastern, or lee, face was seen through a white veil of diaphanous cloud. This did not, however, conform to the south-eastern face, but continued the curve of the north-western slope beyond the summit, its border thereafter descending gradually, and stretching beyond the mountain. To the left of the topmost curve, where the cloud clung steadily to the peak, curls of white vapour, breaking away in eddies, followed each other in procession along the line of

separation between the main eddy and the undisturbed atmosphere of tranquil blue.

3. The Constellations at Sea.—Comprised within the large constellations are smaller groups called asterisms, which have had distinctive names from ancient times. Their dimensions are significant in relation to the functions of the eye. The Pleiades have a diameter of 1°, Medusa's Head in Perseus $2\frac{1}{2}$°, and the Hyades 4°. This angle, 4°, is the whole field of vision of the yellow spot of the retina, the eye within our eye on which we are dependent for accurate appreciation of form. We all know that the twinkling of the stars is part of their charm, and the pre-eminence of Sirius as seen in our latitude is largely due to his unrivalled flashing. But a subtler beauty than the flashing of a single star is the ripple of light which runs through the six Pleiades, which, being all compassed within the small field of accurate vision, are seen as a twinkling group, changing appearance many times a second and undergoing, I suppose, 720 variations all told.

The noticeable groups of the historic constellations seldom exceed 30° in diameter. Although the influence of their names tends to limit the scope of the eye, there are parts of the sky where several constellations group themselves in a single picture. Looking at Zeta Tauri (the star in the lower horn of Taurus), Orion, Gemini, and Auriga, as well as the Pleiades, are comprised in the view. The group is a circle of 60° diameter, which is a not uncommon limit to a broad field of view both among stars and terrestrial forms.

When voyaging under the equator the view at 6 a.m. is the complement of that at 6 p.m., and, as twilight is short, the view soon after sunset and soon before sunrise shows the whole pattern of the stars. A broad band of bright stars ranged along a great circle is strung on a narrower band of glowing light which unifies their sparkling points. This great circle of the Milky Way may be considered as having four roughly equal quadrants. The northern, or Cassiopeia, quadrant, which is above the horizon all the year in England, has neither very bright constellations nor bright nebula. The Orion quadrant on the one side, which is seen in the south on our winter evenings, has brilliant constellations traversed by a single nebulous band of moderate and nearly uniform brightness; the Aquila quadrant on the other side, well seen on our August nights, is characterized by a branching, double band of nebula with bright bosses, traversing constellations of moderate brilliance. In the Tropics we see also the fourth, or Centaur, quadrant of the Milky Way which forms the southern link between the Orion quadrant and the Aquila quadrant. This band, which traverses Argo, the Centaur, the Southern Cross, and the small groups Norma and Ara, combines the varied glow of the Aquila quadrant with the sparkle of the Orion quadrant. The exceptional darkness of the starless sky above and below enhances the shimmer and sparkle of this unrivalled belt which, seen on the voyage

from Colombo to Singapore, forms a long low arch in the southern sky, splendidly displayed in the dry clear air of the North-East Monsoon. The Cross stands upright at the crown of the arch with the brilliant Pointers of the Centaur on the left and the numerous bright stars of Argo on the right, whilst the flash of Sirius in the west and the red glow of Antares in the east show the connection with the more northern quadrants, at this time below the level of the horizon.

The transcendent distance of the stars does away with the perspective crowding towards the horizon which affects clouds, and therefore steepens the vault of the sky. This nocturnal vault requires a certain kind of horizon for its perfect display. From on board ship, completely surrounded by a well-marked, smooth, and level sky-line, the impression is obtained of a symmetrical and steep dome rising from a flat circular plain. The straight sky-line accords with the grouping of the stars, in which the suggestion of a curve (as in Corona) is quite exceptional; and the flat surface suits the constellations, which never have a salient appearance.

When the young moon sheds sufficient light to show the waves but not enough to quench the stars, the watery plain takes on a look of greater size, and the constellations appear to be spread over an ampler dome; and this is perhaps the finest of all views in which we can see other worlds without losing sight of our own.

4. The Three Elemental Lines of Coast Scenery.—The most conspicuous lines in Natural Scenery are those which separate the three geographical elements—Earth, Air, and Water; the land horizon, the sea horizon, and the actual or apparent shore-line. Coast scenery derives its spectacular character largely from the presence of all three lines. They meet at the actual or apparent foot of any promontory not less distant than the brow of the watery plain, and a lofty headland thus viewed dominates coastal scenery as much as the peak dominates mountain scenery. Headlands seen from above are wholly outlined against the sea, which is a more effective daylight background than the sky, so that when the headland is seen from above it gains in strength of tone.

A peculiar beauty of tropical coasts is the low sandspit covered with coconut palm where the columns and crowns of the trees are backed by the blue water. But of all land-shapes the boldest to the eye are Stacks and Skerries, such as the Burlings, which, even if only seen from a passing ship, leave a lasting memory of rugged forms in splendid isolation.

The level line of the sea horizon is so restful that in a view such as that of the Esterel from Cannes the exhilaration of a bold mountain sky-line can be enjoyed in a scene which does not lack repose. The smooth and level horizon also serves to link together opposite promontories, so that the eye can enjoy, and seems to take in, the prospect of a bay as wide

as that of Bournemouth, which, viewed from the East Cliff, has a stretch of 90° from St. Catherine's Point on the left to Durleston Head on the right.

5. The Peaks of an Alpine Range and their Apparent Individuality.— In early twilight, when Venus, standing high, is still the solitary star, the brilliant point holds the eye, but, being "without parts or magnitude," does not narrow the field of view. Indeed, the spread of the surrounding sky is better seen when the eye has this *point d'appui* upon which to rest. I think that the sharp point of a mountain peak, by fixing without narrowing the field of view, similarly helps the eye to master the forms which spread below on either hand.

Mountain ranges of Alpine type provide the finest forms of distant sky-line, the peaks being of sufficient size to appear important at the greatest distance at which atmospheric conditions usually permit of visibility. From the roof of Milan Cathedral on a winter morning, while mists still hung heavy in the plain of Lombardy, I have seen the rays of the rising sun flush the line of Alpine peaks which stretches halfway round the horizon from Mont Cenis in the west to Monte Lessini in the east, each about 100 miles away. The eye easily embraces a long frontage of the peaks, and delights in their rhythm, for although no two peaks are twins they all have a family likeness. Monte Rosa in the north-west, 72 miles away, stands highest, roughly $1\frac{3}{4}°$ above the apparent springing of the foothills from the plain. That an object rising to this height above the horizon of a plain would appear important, is realized when we recall the fact that it is three times the visual diameter of the sun, which appears of imposing size when touching a low horizon Yet even this loftiest part of the Alpine panorama comes easily within the field of view of the yellow spot of the eye, and to this I attribute the fact that so long a frontage can be taken in although there is much detail to observe.

From Bern, the three peaks Wetterhorn, Schreckhorn, and Finsteraarhorn lie eastwards some 40 miles away. The last named, 3100 feet from saddle to summit, projects about $1\frac{1}{2}$ times the sun's diameter against the sky, and in mid-winter I have been able to compare the size of this fine upstanding form with the red ball of the rising sun shining between the peaks of Wetterhorn and Schreckhorn. The appearance of an Alpine peak, however, is determined almost as much by the salient buttress as by the outline on the sky. I well remember an occasion on which I failed to recognize peaks with which I had been long familiar in daylight when I first saw their flat silhouette in the grey dawn. The predominant form in the main range of the Bernese Oberland, and I think it would not be too much to say in all mountain systems of the Alpine type, is the pyramid, using the term for the sides and edges only of that geometrical figure, for the peaks usually rise from an indefinite base. At the Kleine Scheidegg, which is just above the timber line, we

have, close by and directly fronting us, the great triad of peaks Eiger, Mönch, and Jungfrau, which are central in the long panorama seen from Bern. The peaks stand up about 7000 feet above the Scheidegg, the Mönch in the centre being about 27° above level. The geometrical association is so insistent that there is a strong impulse to view them together, but the horizontal angle which has to be embraced is more than 100°, and I found myself involuntarily viewing either the pair Eiger and Mönch or the mass of the Jungfrau and Silberhorn. The former subtend 60° horizontally and form a satisfying view. When looking at the latter, which only occupy 44°, I found myself continually adopting some device to exclude from view the inharmonious form of the Schwarz Mönch on the right. These facts, taken together, illustrate my general experience that a horizontal span of 60° is a full view of mountains whose vertical dimensions are of this order of magnitude.

When many pyramidal forms within the effective field of view lead up to a culminating peak, the eye rests here, and sees the whole as one complex pyramid, an apparent structure. The whole complex, although stereotyped by a distinguishing name, disintegrates on near approach, while the smaller pyramids, which are here sufficient to fill the eye, acquire an enhanced individuality. Places resorted to as climbing centres are apt to be situated at the transitional distance which is so troublesome for viewing great mountains. At Grindelwald the eye experiences distress in the endeavour to take in the whole of the Eiger, a demand imposed by association. About an hour's walk farther, where the glacier portal of the upper mountain region is passed, all is once more well, for each upstanding part has become apparently a structural whole, and these group with one another on equal terms.

The glacier should not be thought of only as a path to be followed or an obstacle to be avoided, but as a field for a day of delightful wandering. Here crevasse, sérac, and rocks pillared on pedestals of ice, seen in the foreground and no longer dwarfed by mountain masses, have a grandeur of which their appearance from a distance gave no promise. After a night spent at the Schwarzegg hut, which stands close to the glacier at an altitude of 8000 feet, I climbed the ascent on the east in the early dawn and reached the vicinity of the Strahlegg pass (11,000 feet) in time to see the flush of sunrise on the culminating peaks of Finsteraarhorn, Fiescherhorner, Mönch, and Eiger, stretching south and west about 90° along a great mountain wall, at distances of from $2\frac{1}{2}$ to $5\frac{1}{2}$ miles. Seen thus across the glacier trough from about the level of the saddles, such peaks make the boldest sky-line in Nature, and the spectacle is in its way unsurpassed as they stand crimson in the rising sun backed by the blue of æther, not of common air. This is a perfect view-point for the upper Alpine world of rock and ice, everything below the tree-line being shut out from sight. From lower stations the most perfect pictures of snowy peaks are seen on chance occasions when an opening in the

clouds reveals some individual form of special beauty, above and detached from the common landscape, standing halfway between earth and heaven. So have I seen the Silberhorn from Wengen and the Weisshorn from Rothen Boden.

Summing up the views of the Great Alps from far and near, we find that from the plains they appear as a row of simple, though not symmetrical, pyramids; that from the nearer foothills each individual, which now subtends a large angle, generally appears as a pyramidal complex trending upwards to a culminating peak; and that, on a yet nearer approach, this complex (which has not the structural individuality of a volcanic peak) vanishes, and is replaced by a number of visually independent pyramids.

6. The Grouping of Trees in a Wood, and their Place in the General Landscape.—The woodland canopy which most resembles the dome of sky is seen in groves where trees of spreading habit, such as beech or oak, grow far apart. Around and overhead, distinguishable forms pass imperceptibly into regions beyond the ken of the eye, the seen melting mysteriously into the unseen, and thereby making our environment one with Infinity. In this connection it should also be remarked that the distance ordinarily visible horizontally within a wood is that within which stereoscopic effect is direct, and that tree-trunks are very effective stereoscopically, so that the feeling of distance is considerable.

Amidst the unbroken weaving of sinuous lines in the beech grove there is none of that feeling of disappointed effort experienced when the eye is unable to take in the abrupt outline of a mountain viewed too near at hand. Groves of spreading trees with ramifying roots are most beautiful upon gently undulating ground, so that the view above, below and all around is uninterrupted by any straight line. The columns of the fir forest, on the contrary, make a harmony of straight lines on a steep hillside of uniform slope. The effect of the perpendicular cliffs near Beatenbucht on the Lake of Thun, and of those which overlook the Lauterbrunnen Valley, is much enhanced by the tall straight pines which stand as sentinels among the craggy limestone battlements. On the lesser Alps near Les Avants and Caux the spires of the spruce rhythmically reinforce the form of the rocky peaks, particularly when tone and colour are approximated by a powdering of snow. Between Alpiglen (5300 feet) and Kleine Scheidegg (6800 feet) we reach the climatic limit of the coniferous forest. Here the close woods, kept perennially young by cutting and planting, give place to scattered pines, rough-barked, gnarled, and twisted, rugged old fellows making an effective foreground for the great Alpine peaks, which from most points of view suffer somewhat from lack of foreground.

A leafy tree is a three-dimensioned form patterned with the concordant shapes of the massed foliage of boughs, and in order to understand the part which detached trees play in scenery we must take account

of the limits of distance between which the form and pattern can be appreciated. The form can be taken in at a distance equal to the height of the tree, say 50 to 100 feet for the finer varieties of English trees when they have attained the symmetry of full growth. The radial symmetry of the boughs so binds the form that a very large angle can be taken in laterally.

An object has the apparent diameter of the sun at 107 times its own distance, so that trees of 50 to 100 feet should not be insignificant at a distance of 1 and 2 miles respectively, and I have noticed oaks and elms at such distances in the plain of the Weald beautifully shadowed in the early morning light. But where the view across the Wealden valleys is bounded by hills 12 miles away with trees along the crest, the upstanding forms are in every respect insignificant. Yet their projection is sufficient at this and even greater distances to do away with the suave or the vigorous rhythm of an undulating or rugged crest. Thus extensive views across the Weald are best when bounded by the treeless downs; and in Devon it is when the bold unbroken sky-line of Dartmoor rises in the background that the element of grandeur is added to the prettiness of the scenery.

Speaking broadly, the order of height of trees and mountains in the Alpine region of Europe is in the proportion of one to a hundred, and in the harmonious grouping of a belt of trees with apparently compact foliage backed by a serrated mountain crest-line, the former is in the colour foreground of purely local tint, the latter at a distance where atmospheric tone and colour predominate.

7. The Detail of Vegetation viewed at Short Focus.—It is in leaves and flowers that vegetation shows the higher developments of symmetry, but only in the Tropics, where leaves and fernery are on a giant scale, can their symmetry be viewed together with the landscape, for the eye has not sufficient depth of focus to take in objects whose distance is to be reckoned respectively in inches and miles. There are however natural surroundings and modes of viewing in which such forms as lowly flowers, heath, and waving grass fill the whole view without intrusion of distant objects. This is so when we happen to walk with the eyes cast down. The primrose flower 7 feet in front then subtends the same angle as the sun or moon. When we are seated on the ground the head usually inclines, so that the horizon draws in to a circle of, say, 30 feet radius. On the fine carpet of pasture or heath beautiful structures then surround us, each subtending a sufficient angle for its form to be appreciated. The eye speedily forgets the smallness of the linear scale, and no thought of insignificant size mars the appreciation of a view which contains more objects possessing fine symmetry than are to be seen in the distant landscape.

There are also circumstances in which the smaller forms of vegetation are seen in focus together with the larger, thus giving another kind of

beauty, that of miniature. This charm is found in a pine wood where bracken spreads its fronds as branches of a miniature forest below, and toadstools stand with stalks as straight and columnar as the trunks of the trees.

Postscript.—Such in brief is the Grouping of Forms in Natural Scenery which I have noticed in travel by land and sea, but when travelling by air the grouping is different, and when among the clouds gives new combinations of extraordinary beauty, as I have lately seen in preliminary flights. I propose to attempt the correlation of Scenery from the air with that from the land if I am able to attain the necessary facilities for flying.

THE TUAREG VEIL

H. R. Palmer, C.M.S., C.B.E.

I HAVE read Mr. Francis Rodd's very interesting paper (*Geogr. Journ.*, January 1926) on the origin of the Tuareg, and the subsequent discussion on it. It is to be hoped that the problem may receive further attention from archæologists. In the meantime I venture to put forward certain data which are material to the issue.

Firstly, as regards the word "Tuareg"* (Tawarik) itself, current explanations of the word are not very convincing, for there is no evidence that the word was invented by the Arabs, though the form Tawarik first occurs in their works as the correctly formed broken plural of Targi.

As Mr. Rodd points out, the ordinary name for the Tuareg proper, the so-called "nobles," is the root MZGh. That root, however, connotes "males," "masters," "warriors" rather than the tribal or national unit, the proper term for which is in the singular *ili* or *alil*, and in the plural *il-lam* or *ilella*. In the legends, still current in the Chad region, of the Hilalian Arab invasion of Fezzan in the eleventh century and the deeds of the hero Abu Zeid el Hilali, the term used to describe the Tuareg who opposed Abu Zeid is always *Ullam* or *Illam*. The modern tribal name *Ullim-miden* is thus composed of *illam*, "members of the tribe," and *miden* (Tamashek plural = men).

In the eastern half of the Sudan the common word (usually classed as Arabic) for a country or tribal area is *Dar*. The word is however not really an Arabic word, though adopted and used by the Arabs as such. It is the pre-Arab (*i.e.* Berber) word for an "encampment," and from this meaning of "camp," *Dar* or *Tar*, with its variant *Dala*, acquired in many parts of the Sudan and Sahara the meaning of "hill," since camps were frequently on a hill or elevated ground.

In the Chad region the present use of this word or root *Dr* among

* The author would spell the name Tuwareg, for which there is much to be said: but in an uncertain case we have preferred to retain the spelling Tuareg as used in Mr. Rodd' papers.—Ed. *G.J.*

both Arabs and Teda-Kanuri is *dor* or *dar*, meaning an encampment; *dirdir* meaning a fence, palisade, or wall. Thus in the Kau-war Oasis the Tebu title of the chief is *Dir-deh;* the capital, so to speak, of the oasis being called *Dir-kiyi(n)*, though in ordinary conversation the *n* is dropped and the name is pronounced *Dir-kụ*. The meaning of the name *Dir-kụ* is, in fact, "the camp *dir* of the Kiyin or Keyin," *i.e.* the camp of the Zaghawa Tuareg or Beli who were the first rulers of the kingdom called afterwards Bornu.

The word *Kiyin* with its variants *Kinin* and *Kindin* is the normal word for "Tuareg" among all the Sudan peoples east of Lake Chad. The masculine singular of this word is *Kiyi*, making feminine *Kita* or *Kinta*—whence the tribal name *Amakitan* or *Maki-dan* (*Makeda*), and the Berber word *Kinta* or *Kita*, "mother," whence *Kita-ki* or *Kinta-ki(t)* (Candace), "my mother."

It will be seen that a "Tuareg" in this region was called *Tar-kiyi* (*Targi*), sometimes pronounced *Tarauwi*, which quite naturally among the Arabs acquired a broken *Tuwarik*. Perhaps the clearest proof that these early rulers of Kanem were Tuareg lies in the word *Dụgu*, as in (1) the word for the grandson of a king; (2) the third mythical Mai of Bornu, whose name is given as *Mai Dụgu*.

Dụgu, though now in the word *Mai-dụgu*, meaning any grandson of a Mai, strictly meant the son of the king's daughter, *i.e.* it was a word parallel to the Tamashek *tégasi*, which latter means "child of a sister" and so "the heir," *teg* or *dụg* being the feminine of the Tamashek *-ek* or *-eg* = "son"—from which it will be seen that the Tamashek word for the "veil" or "covering" which the Imoshek wear, viz. *Tegelmist*, is really *Teg-el(l)am-ist*, *i.e.* the covering of the illam or "nobles."

The generic name *Sanhaja* used of the Tuareg by the Arabs is, I think, only the Arab modification of *San-gara* or *San-a-gar*, which is the same word as *Zenj* on the one hand, and *Senegal* on the other.

Mr. Rodd does not indicate the detail of his suggested "Nordic" origin of the Tuareg, but accepting his hypothesis broadly to mean Northern races, it is suggested that if Nordic peoples be included in the so-called "Iranian" nomads of Asia, it is possible to reconcile both his idea and those of the Arabs on the subject.

It will be understood that the names of the Tuareg peoples as given by Ibn Khaldun, *i.e. Lamta*, *Lamtuna*, *Kitama*, *Kitala* (*Gaedala*), etc., are nothing more than variants of the names mentioned above, *Kitala* (*Keyi-Dala*) still surviving in the Teda-Kanuri title *Ketala*, *i.e.* the Bornu title *Kachella*; *i.e. Keyi* (*Ki*), "ruler of" *Dala*, "the camp."

The two oldest Sudanese names for the Tuareg are therefore:

A. *Ili*, pl. *Il-am* (or *Illam* for euphony).

B. *Kiyi* or *Keyi*, pl. *Kien* or *Kinin*, which has in fact another plural in the tribal name *Koiyam* (for *Kiyam*), who trace their descent to the Beni Kiyeh of early times in Kanem.

Let us suppose that the root word *Kiyi* (written also *Kayi* and *Keyi*) is the same as that found in the case of the Kinaiḥḥi or Kinaḥni, called also Xv͡a (Kina), a people who according to the Tel-Al-Amarna tablets came from the region of the Persian Gulf and colonized Phœnicia, being, presumably, a part of the peoples who introduced the "horse" to Babylon and Egypt about 1700 B.C. Then it would not follow that because these races only arrived in North Africa as colonists towards 1300–1000 B.C. and were then, so far as we know, unveiled, that races homogeneous to them did not at a much earlier period migrate from Iran to the Persian Gulf, the Arabian Peninsula, and Horn of Africa, and become the Tehenu who, as Mr. Rodd points out, were as early as 2500 B.C. established in the oases near the Nile. It may be noted that the Egyptians called the Iranian nomads *Dahi*. Such a supposition gains very considerable support from the data collected by Prof. Ridgeway with regard to the advent of the "horse" in North Africa, as well as from the Tamashek words for horse and ass which may well bear some relation to the Aryan ἄσπος.

There is also good reason to suppose that the early civilizing influences which acted (*a*) in the extreme west of Africa—the Lixus Wadi Draa, and (*b*) in the early civilization of Garama (Jerma), were mainly Syrian, *i.e.* Phœnician, and did not come direct from either Egypt or Europe. That these influences must be classed as Semitic both as regards language and otherwise, and that there is no trace of a veil among the Libyans of the Greek age or on the Egyptian monuments, does not preclude the supposition that races in part homogeneous to them in passing through the Arabian Peninsula and the Horn of Africa did not (*a*) while retaining to some extent their original language, modify it considerably in the course of years, (*b*) acquire the use of the "veil."

The theory that in fact the two groups were in origin the same, albeit the ancients believed in two widely secluded but homogeneous races of Ethiopians, might remain pure speculation were it not that (*a*) a definite Elamite migration from the Persian Gulf to the Horn of Africa is believed by scholars to have taken place about 2000 B.C. or before; (*b*) the Arabs and Sudan tradition hold as definitely that the Tuareg first came from Syria to Yaman, and thence to Africa and the Sahara.

That *El-am* (Elamites) is the same word as *Il-am* is perhaps too easy a supposition to be true, and yet it is difficult to see why *El-am* should not mean "people of El," *i.e.* God, as it would do in Berber languages akin to Kanuri.

It is true that Ibn Khaldun's Berber origins are somewhat confusing in detail, but in broad outline his account does not materially differ from that suggested above, for (1) He brings the Sanhaja and Kitama (*i.e.* the Tuareg or Ilam) from Yaman. He says they multiplied in the "rif of Abysinnia," and afterwards spread west. They are his

"Second race of Sanhaja"; *i.e.* though he calls them *Gara* (*San-gara*) they were clearly not the same Gara who were in ancient times the subject peoples of Garama (Jerma), the Tebu and Teda races of to-day—the Garawa or Guraan. (2) Ibn Khaldun's southern Berbers are in general termed by him *Beranes*, *i.e.* by the word which in Bêle, Zaghawi, and other Berber languages of the Eastern Sudan means "person," or in the plural "people." The present local words for man (*i.e. vir*) vary, *e.g.* in Teda, a man is *angi*, pl. *anya*, and in Kanuri, *kwa*, pl. *anwa*; whereas in Kanuri *kam*, pl. *am*, means people, and in Teda a person is *anu* and people *amba*. The equivalent for man (*vir*) in Tamashek is *masigh*, hence Ibn Khaldun talks of the Beranes being children of Masigh.

As regards the Northern Berbers, Libyans, on the other hand, he derives them from Madghis (mazigh) el Abtar or el Botr, who, like Beranes, was a son of Canaan, son of Ham. Here it may be suggested we have the simple name for the Phœnicians, who were called by the Assyrians *Surru*, by the Egyptians *Dara*, and in early Latin *Sarra*. *Botr* or *Abtar* may mean, it is suggested, Aba Tar or Abu Tar, the Phœnicians, whose country, originally called Usu or Uzul, provided the people of Kanem and of Bornu with their name for Fezzan, "Uzlan" in Teda-Kanuri, and its old capital "Zeila of the people of Uzu"—Zeila Uzlan—near modern Murzuh. To this day a Tuareg is still called by the Hausas, a Buzu, *i.e. Ba-Uzu*, while they called Syria "Surukal" (Suru-akal), and a Syrian (in fact, any white man) *Ba-Ture*, the corresponding words in Bornu being *Tura* and *Wasiri* or *Wazili*, the latter of which might as well be written *Zeilawa*.

A lengthy discussion about the origin of the Tuareg veil would be out of place here, but such evidence as exists indicates that its use, originally ritual in some way, became a badge of rank. From the Tamashek word *-am*, mouth, it is called *amawal* by the Fulbe and Hausas, and by the Kanuri and Teda it is called *Fụni*.

The key to its original signification seems primarily to be connected with veneration for the acacia tree, particularly the species *Acacia seyal*, which has a sweet and rather strong scent.

An Eastern Tuareg (Kindin) will not willingly, it is said, look on an acacia tree or come near it, much less handle the gum (gum arabic) or carry it on his camels. In fact, it is the "totem" of the Kindin in general, and it is said that they closely cover their noses and mouths with the "veil" if they smell an acacia tree. They are said to be afraid of *iskoki* (spirits) which haunt the acacia, and which are liable to afflict them with leprosy, so they think.

In Tamashek the name for two species of acacias are *aghar* and *saghar* (*Acacia seyal*), and in Tebu the word for syphilis is *aghar-anna*, which appears to indicate that the real author of the affliction was the

* *Akal* is in Tamashek "land."

Mother Goddess Amma or Anna (Carthaginian Tanit), *i.e.* the Babylonian Ishtar or Nana.

It is also at least noteworthy that the Arabic word for this "veil" is *lithan*, the root of which means (1) to kiss, (2) to muffle oneself, and then of a camel "to go lame," it is said, owing to pebbles on the road.

The root of *litham L-TH-M*, curiously enough, comes in the dictionary next to the root *LTH*, which means to "exude gum or resin," and which looks as if originally the Litham were a "people" who had to do with "gum and its collection."

The Arabian *El-Lath* was, of course, the feminine of *El* and the Semitic counterpart of the Babylonian *Nana*.

It is suggested, therefore, that the adoption of the "veil" by the Ilam was originally due to awe of the goddess Nana or El-La*th*, who was personified in the acacia tree, the acacia being in this way the "Pene Baal," or "face of Baal" (the epithet of Tanit on Carthage votive-tablets), *i.e.* the outward manifestation of the unseen Baal, whence the veil itself was by certain Berber races called "Pene," the Kanuri Fụni, and possibly the Egyptian Funḥ, a name apparently applied to Asiatic bandits in general of the type of the Tuareg.

It may be added that the Tamashek root *ghar* for acacia occurs in the Tebu *kingar*, Kanuri *Karamga* (*Acacia seyal*) in the Hausa *ƙaru*, "gum arabic," and in its Kanuri equivalent *ƙolƙol*, while the *Acacia verek* is also in Kanuri called *kindil*.

It is difficult to see how a race could have the acacia as a totem, *i.e.* believe themselves descended from the acacia tree, unless they had lived in the Sudan belt for a very long period. It is also possible that at one time they picked the gum with due ritual once a year.

NOTE ON MR. PALMER'S PAPER BY MR. FRANCIS RODD

Time and space forbade entering into such detail as I should have liked to in my paper on "The Origin of the Tuareg." Some of the points which have now been raised by Mr. Palmer had nevertheless received consideration. The whole problem has been dealt with more fully in a book which has recently appeared from Macmillan's house. In it the *MZGh* root was discussed in some detail. I absolutely agree with Mr. Palmer that the names containing this root are descriptive and not national. I do not however feel that the root *ILI* or *ALIL* is vastly different in this respect; moreover, it is rarely used by the Tuareg. It appears to have the value of an epithet. Arab evidence to the contrary has scarcely more value than the known Arab misinterpretation of the name *Tarki* or *Taṛqi* (plural *tawarek* or *tarkiyin*). The latter name is also discussed at some length in my book. I incline to the view, on the indications given by Leo and others, that this is the proper name of one tribal division, which, by reason of that section having become better known to the Arabs than the other groups of Tuareg, acquired the significance of a proper name for the whole race and was then given a fictitious etymology. I am afraid that I do not concur in the suggested derivation of the name *Aulimmiden*. The word is a plural form of *Limmid*, which has the same root and application as *Alamt*, *Lamt*, and *Lemta* (cf. de Foucauld's dictionary, vol. 2, pp. 65,

72, and 344. Also Barth's 'Travels,' etc., vol. 5, p. 552). In any case the etymology suggested by Mr. Palmer savours of redundance.

I am hardly competent to discuss the origin of the word *Dar*. The usual Arabic word *Dar*, دار (as in Dar el Islam), I think I am right in saying, occurs in pre-Islamic poetry; if then it were borrowed from the Berber, this must have occurred a very long time ago. In Africa I distinguish between *dar*, دار, from the Arabic, and the Berber root *DGh*. The latter is found in such words as *Adghagh*, a mountain, or *Tadghagh*, a small hill (see De Foucauld, vol. 1, p. 170). Bates (in his 'Eastern Libyans,' p. 79) discusses this root, giving various examples of its occurrence in Libyan place-names. He calls the root *DRR*, but I think also confuses the two, probably distinct, roots. The final consonant is important; it is either a ر (re) or a غ (ghen), and among Europeans alone do these seem to be interchangeable. In Arabic or Berber ر (re) may become ل (lam), or غ (ghen) may become ج (gim) or ق (qaf); but the one is liquid and the other a guttural. I hazard the guess that دار, *dar*, is an Arabic word, but that the root *DGh* is Berber, the former being derived from the radical meaning "to encircle" or "go round," the latter signifying "hill." The situation of camps on hills is perhaps etymologically only fortuitous.

I do not feel that I can usefully comment on the suggested derivations of *Kiyin*, *Kindin*, *Kinin*, or *Dirki*. I agree on quite other grounds that the early rulers of Kamen probably were Tuareg; Mr. Palmer's origin for the name *Tarki* may indeed be correct, but one cannot be too careful not to base history on philological or linguistic evidence for it is notoriously misleading.

I think Mr. Palmer is wrong about the derivation of the word *Tagilmus*, the Tuareg veil. *Ag* certainly means "son," but the prefixed *T* does not refer to *Ag*. The *T* is part of the common feminine or diminutive form; the word is a diminutive of *Agulmus*, meaning a large piece of stuff (De Foucauld, vol. 1, p. 311). The words perhaps come from the root verb *Egli*, meaning "to knot" or "tie up" or "wrap" or "fold." Similarly, further on in his note Mr. Palmer is probably incorrect in his derivation of the word *amawal*, the lower part of the Tuareg veil covering the mouth. This word is regularly derived from the root verb *AWL*, meaning "to turn" or "change direction," and by extension "to hitch up" or "fold up" or "catch up (stuff)." The reference is of course to the fact that the lower part of the veil is the only piece which can be moved without undoing the whole strip of cloth, and is, in fact, hitched up or folded back to enable the wearer to eat and drink.

Turning to the more general question raised by Mr. Palmer, I regard the Kitala or Gadala, and the Lemta or Aulimmiden sections of the Tuareg race as distinct; nor is there enough similarity in their names to identify them with one another or with the whole. The Sudanese name *Ilam* is probably more akin to the word *Lemta* than to the root *ILI*, which, as I have said, I am not aware that the Tuareg use as a national name for themselves. The connection between *Ilam* and *Lemta* is moreover justified by the evidence, which indicates that the Lemta migrated into the Chad regions from the Fezzan, and thence westwards. But I cannot see very much etymological justification for identifying them with the Kinin, though the latter name certainly does refer to them in the language of the southern folk, even if not in that of the Tuareg themselves. A *Ki* root in *Dirki* and *Amakitan* is too slender evidence for me to regard the *Kinin* name as Tamashegh.

I agree that the Tuareg may have come to North Africa even as late as

1300–1000 B.C., but mere coincidence of a *Ki* root does not seem enough evidence for associating them with the *Kinahhi*, however tempting this may seem. The Tuareg probably did come in from the Eastern Mediterranean, but the Egyptian records of people who, we agree, were their ancestors prior to this date must be considered.

I have dealt with the "Madghis" Berbers and Ibn Khaldun's second race of Sanhaja very fully in my book, to which I must refer any one interested in this topic. Unfortunately, Mr. Palmer is as much at a loss as I am to account for the commencement of the practice of veiling, which must have begun some time between the fourth century A.D. and the time when the first Arab authors referred to them as the Muleththemin.

There are certain totemistic survivals among the Tuareg. In support of Mr. Palmer's totemistic theory on the origin of the veil I might quote the name of a tribe in Aïr, the Kel Tamat—the People of the Acacia. Further, my suggested derivation of the Tagilmus from the verbal root meaning "to wrap" is in accord with the meaning given to *Litham*, the Arab equivalent for the veil. Nevertheless, I do not see why the Tuareg, who were once not veiled, should all suddenly have taken to this practice on account of their veneration for the Acacia at a time in history when Christianity was strongly in the ascendant in North Africa and the worship of Tanit and Baal was distinctly on the decline.

In conclusion, I agree with Mr. Palmer's main line of theory while reserving myself the right to criticize his etymology and question much of his evidence. I am not convinced by the suggested origin of the veil. I am ready to investigate the theory that the origin of the Tuareg is to be looked for in Persia, whence they came through Syria to Africa; it accords with the result of my independent researches, which only covered their migrations after their arrival in this continent. But I had not ventured to look for their origin further afield than the Eastern Mediterranean. Readers of my book will see that my deductions are, broadly, not inconsistent with Mr. Palmer's ideas on this subject.

F. R. R.

NOTE BY MR. RONALD DE PASS

I have read with great interest Mr. Rodd's paper on "The Origin of the Tuareg," published in the January *Geographical Journal*.

As regards the origin of the wearing of the veil, Winwood Reade states in his 'Martyrdom of Man' that the Tuareg give the following reason for covering up their mouths: they say that "it has the disgusting office of chewing the food, and is therefore not fit to be seen."

I have frequently asked Tuareg to uncover their faces for me to see, and have nearly always found them willing to oblige on my offering them a reward.

GEOGRAPHY AT THE IMPERIAL INSTITUTE

I

THE exhibition galleries of the Imperial Institute, which have been closed for some months for decoration and re-arrangement, were opened again to the public on September 29, and the Governors, to mark their sense of the important part the Institute should play in public

education, invited a great number of London teachers to inspect the galleries on the evening before. In his introductory speech on behalf of the Governors, Mr. A. M. Samuel, M.P., defined the basic function of the Institute as follows: To increase the production of British Imperial raw materials, and to provide additional uses for them in manufacture or in food consumption; to interest schools and continuation classes in the resources of the Empire; and to carry on the work of instruction which is described in the word "Wembley."

Mr. Ormsby-Gore, M.P., Parliamentary Under-Secretary of State for the Colonies, pointed out that while the self-governing Dominions had their own offices in London for the display of products, as well as galleries in the Institute, the Colonies, Protectorates, and Mandated Territories must rely on the Imperial Institute for the publicity they need; and they deserve the special attention and study of this country because the Imperial Parliament is responsible for them: responsible, for example, for Nigeria, which contains as large a population as Canada, Australia, New Zealand, and the Union of South Africa together; and responsible for British Malaya, whose exports in 1925 surpassed in value those of the whole of the rest of the Colonial Dependencies together, and in value per head of the population exceeded that of any other exporting country in the world. Only at the Imperial Institute can some visual notion be gained of the economic geography of the Empire as a whole. Better maps and better teaching must become realities in the lives of the people. Politics often cloud our vision of realities, and economic problems can ultimately be solved only in their relation to geography.

The Duchess of Atholl, M.P., Parliamentary Secretary to the Board of Education, referred again to carrying on the work of Wembley, and pointed to the New Zealand Court as evidence of the lines on which the reorganization of the Institute had been begun.

So much stress was laid upon the influence and pattern of Wembley that we may be allowed now to say without disloyalty that the geography of Wembley was deplorable. The whole plan of the exhibition centred upon a lake which lay most ungeographically halfway up a wide gentle open slope. One coast of the lake was deeply embayed: the opposite shore a dead straight line, with two immense principal buildings parallel to it but below the level of the lake. The trade routes of the Empire were demonstrated on an enormous model which warped so much that the ocean withdrew in places and displayed the "continental shelf"; while model steamships buzzed to and fro without ever entering any port, or ever traversing the Mediterranean and the Suez Canal. The relief model of the Gold Coast was exaggerated twenty times in vertical scale, and made to look like the Dolomites coloured disagreeably. The Kaieteur Falls in plaster, crowded into an external alcove, made a lamentable travesty

of the most exquisite fall in the world. The pipe-line of the Anglo-Persian Oil Company climbed isolated hills so tremendously steep that one wondered why it did not go by the apparently shorter way round on the level. Apart of course from the exhibits of the official Survey Departments, and—may we say it?—the model of Mount Everest, which was true to scale, the relief maps and geographical models of Wembley are best forgotten.

It will be easy for the Imperial Institute to improve upon that example; but impossible to obtain results worthy of the galleries unless the Director is given funds to establish a studio, to appoint a craftsman trained both in geography and in the practice of lettering on the best patterns, and capable of founding a new school of mapping and modelling for exhibition. The artist-geographer has plenty of examples to avoid: a map of Nigeria in which the Niger is not found without difficulty; a relief model of New Zealand coloured shrimp-pink up to the snows. He will, we think, have to go far back for suggestions: and we commend to his consideration almost the earliest of published maps—the Rome edition of Ptolemy.

The maps and models are but a part of the machinery by which the raw materials are to be displayed. There must be many opinions as to the principles on which a gallery of economic geography should be organized. And being assured by the Director of the Imperial Institute that he would welcome constructive criticism and suggestions, we invited Professor Lyde of University College and Miss Hosgood of Bedford College to give him and us the benefit of their views on the matter, which will be helpful also to teachers who wish to make the best educational use of the Institute under its new *régime*.

II

This short article embodies the opinions of the three senior members of the Geography Staff at University College, London. Each of us visited the galleries separately, and formulated separately in writing the impressions left by the visit; and if the combination of opinion has value, that value is not diminished by the fact that the three reports were practically—often even verbally—identical in all essentials.

Such an exhibition should show us the right things in the right way; and, psychologically, "right" means in the proper time and value sequence, first things coming first both historically and geographically. Of right things there may be an almost unending series, but probably there is only one right way, and it must be geographical.

The galleries contain an immense, comprehensive, and representative collection of Empire products, with well-chosen *tableaux* illustrating typical scenery and activities; and a great deal is really invaluable in itself. But without a large amount of knowledge or expert guidance, much of it would not be of great use. Indeed, children should not be

encouraged to visit the galleries without a good teacher; but in the hands of a really good teacher, the collection would be of real value to pupils from all kinds of schools—up to the age of eighteen or nineteen.

The difficulty is that more attention is needed to the geographical background, and more correlation of the products with the physical and economic conditions under which they are produced. That is to say, with the present arrangement of the specimens and the wording of the explanatory "text," the exhibition will scarcely be as great a success as it deserves unless there are guides with sound and wide geographical knowledge and a highly developed sense of proportion. The specimens themselves are excellent, and all have a deserved place in the exhibition: indeed, practically all the models and nearly all the maps are of quite unusual excellence. But they make a collection, not a selection; and that is where they may fail as educational agents.

This absence or neglect of selection shows itself in many ways, *e.g.* in the lack of proportion and proper sequence in the relative importance of products in any given colony, and in the relative importance of any given commodity in the world supply. There should be more maps on the lines of those in the India section, more models on the lines of those in the Australia section, and more descriptive and explanatory "text" everywhere; and this "text" should be appended to *all* the exhibits—pictures, products, models alike.

If this was done, it would become obvious in the doing of it that not enough emphasis is laid on what is really typical, both in time and in place, or on the geographical causes which make it typical. And I would certainly extend the full meaning of this to the pictures. The scenery is, and should be regarded as, a distinct asset as well as an attraction; and it could be made most significant and illuminating by "text" on the structure, the process, the age, etc., of the features shown.

I would like to justify these criticisms by definite reference to the various sections and exhibits, with the suggestion that the effect of the whole at present must, I think, be exactly like that of a map on the uninitiated. I do not wish for a moment to have any of the specimens removed, and am quite aware of the prohibitive cost of arranging them in narrow "one-way" galleries in their proper historic and geographical order; but I would like to see a re-arrangement, and earnestly hope that money will be forthcoming for that purpose.

India.—One enters the section direct from the road by the east door, and receives an extraordinary favourable impression at once. The collection is representative, and both mapping and models are simply admirable; and the "text" is good, full, and comparative. But after reading, under the population chart, that 80 per cent. of the people are engaged in agriculture, one is put out of focus by finding that the nearest exhibit is a series of six cases of "pretty" minerals!

When one gets to the agriculture, it has some excellent illustrations,

especially models of methods and operations; but what a queer order! It begins with forest. Presently four cases of grain emerge, side by side, —rice, wheat, millet, barley,—but without a word about their relative importance, which might be suggested even by the order of the cases. If millet comes before wheat, a child will begin to think that it is more important than wheat. In this case the mapping of the crops is on a wrong basis—the percentage of cropped land occupied by the crop, as though all of them gave the same yield per acre or the same number of food units per acre. With a few changes of this sort, the India section would be of very great interest and value. Even such things as the picture of the vessels in Colombo harbour during the N.E. Monsoon or the graphs of the variable output of rice might almost make a lesson in itself. The same is true about the model of soil-erosion prevention in Malaya—which is dreadfully in need of "text."

In the south block **Australia** revives the thrill of the first glance at India. The physical environment is well shown in a series of statistical and other maps imposed on relief models—miscalled "contour" models. The individual exhibits—except the metals—are arranged with regard to relative importance, and the model "farms," etc., are delightful; but they would all be improved by "text" explaining the conditions, and it is as wrong economically as historically to put the metals at the *end* of the exhibit.

The physical geography of **New Zealand** is made very human; and the large model, though ugly, gives a striking starting-point for a talk on air-photography of relief. But the rest of the section is poor and almost stupidly arranged, with little that is typical. The illuminated models of picturesque scenery are very pretty and interesting, and could easily be made educational—by explanatory "text"; but why only one referring to the dairy industry, and only one about sheep? And why, on the contrary, such a fuss about the felt-hat industry? The dairy and the sheep industries should have been the focus—the obvious, unescapable focus—of the section.

Canada does present us with a clear and logical *order*, traversing the three great natural regions of the Dominion from east to west—the historic sequence. But in the east the country seems to have *no forest*, *no wood-pulp*, *no water-power*, only a small dairy industry, and somehow a climatic chart seems to be responsible for the presence of mica. The prairie does not seem to have any coal or lignite, although the solution of the problem about the extraction of oil from brown coal opens a tremendous prospect for Canada under conditions where there will no longer be daily fear of the "well" running dry. On the Pacific coast the timber exhibit is technical, not geographic; there is no fruit, and no fish. So, although seeming to be orderly, the exhibit is far from being representative It also lacks statistical mapping and statistical diagrams. But, here again, a little rearrangement and a good deal

more "text" would make the section invaluable for all sorts of schools and scholars.

It only remains to add that the most valuable help which the Imperial Institute can give to University students lies more in the extension of its invaluable publication of geographical material than in these galleries.

L. W. LYDE.

III

The Imperial Institute Exhibition stands out distinctly from others, as it is designed to be a permanent effort to give practical illustrations of economic conditions throughout the Empire, and to assist the serious study of them. That is, it aims at being more than the average museum collection, and more than merely an interesting display. It must, therefore, while preserving so far as is possible an attractive presentation, be controlled by other considerations than those of scenic effect alone. The task is without doubt difficult: how difficult only those responsible for the details of reorganization can estimate fully; and it is fitting to register at once an appreciation of the serious efforts being made to develop the exhibition in such a way as to make it of real value.

The galleries must cater for two chief classes of visitors—for the more or less intelligent casual visitor, with an everyday interest in what he sees but with little idea of its interpretation, and also for the conducted parties of school children or adults making an orderly tour. For the children the present plan of procedure is, it seems, for preliminary tours to be made, under specialized guidance, by the group teachers, who subsequently conduct their classes. The plan, while it has obvious advantages in economy of time for the specialist, has also, it is feared, certain potential disadvantages, including those arising from the possibility of "accumulated error."

Such being the conditions, it is evident that there must be two outstanding aims—effectiveness of individual exhibit, and clearness of general plan. Obvious as this may seem, it is worth mentioning, since both ideals rely mainly for their achievement on the same thing—a very resolute limitation of the number of exhibits. Complete representation is impossible, and stronger than the actual limitations set by space or cost of production should be those due to the selective capacity of the organizers. That such selective powers have not, so far at any rate, been in full operation is revealed by even a cursory inspection. For there are parts of the exhibition that are far too crowded, and yet contain among the masses of exhibits some that are of no practical value, or are even worse than useless. Some of the so-called relief models, for one example only, are merely grotesque. From whatever source they were obtained, or for whatever original purpose they were included, in the interest of the exhibition, and out of consideration for its final reputation, they should surely be immediately removed. The task of reorganization,

further, is still in its very early stages, and after allowing fully for the exigencies of space, lighting, etc., a considerable rearrangement of the actual placing of some exhibits, whereby they may be brought into a more logical order, seems both possible and essential.

The extent to which the ideal may be approached varies, of course, very much with the area or topic under consideration, and there will be as many different estimates as to what should or not be included as there are methods of teaching economic geography, or one might even say as many as there are teachers of the subject, for few other subjects offer such opportunities for individualistic methods of approach. But all areas and all methods require some adequate representation of location, both as regards world position and with more detailed reference to the British Isles; require, also, indications of the conditions of relief and climate, and of those of production, distribution, and consumption. In nearly all sections such fundamentals have received at least partial recognition. The work of replanning has, it is understood, proceeded furthest in the New Zealand Court, and though, as a fact, the total contents of this section do not seem to reach the level of some other courts, it is useful and convenient to examine this section in some detail. Especially is this true since from many points of view the region is one of the easiest with which to deal in this matter of graphic illustration.

First, then, with reference to the actual content of the courts. While some form of illustration of most of the simple data of economic geography is included here, beyond the introduction of a world-map of complicated detail the important consideration of position is entirely neglected. A much more effective illustration of world position, and in particular of position with regard to the British Isles, with representation of distance in terms of time, is necessary and could be very easily supplied.

Beyond this, the study of the area itself begins with that of the relief model—one of the most conspicuous exhibits, but one that is by no means the most satisfactory. It is well exposed, of suitable scale, but in colour is more than unattractive, and in proportion to what must have been a heavy cost of production it illustrates very little. Indeed, it merely conveys to the onlooker some vague idea as to the lie of the land and the position of the chief railway routes. The value of any relief model, unless possibly that which represents a definitely restricted area and which is constructed with considerable accuracy, is always to be debated, and the model here would surely give rise to highly erroneous ideas, unless its use is accompanied by more explanation than is possible under exhibition conditions. Consider, for example, the position of any one attempting to treat such important features as those of the Continental Shelf, the drainage systems, or glacial areas—all features with considerable economic significance, but for all of which the model as it stands is practically useless. On the other hand, it could be made really valuable for some purposes by marking thereon the main vegetation belts, a matter

apparently of easy execution, and illustrating most successfully the correlation of vegetation with altitude. The model, further, might indicate "human regions" of the islands. It certainly should show lines of external trade connections, and connections with the islands' ports, and possibly might show in addition the character of the trade. For even the simplest teaching from such a model reference to climatic conditions is naturally essential. But, so far at any rate, there are no illustrations of climate, and one of the first additions to be made, it is suggested, is that of climatic maps, to include at least maps of rainfall distribution, both spatial and seasonal, on a sufficiently large scale, and also some form of representation of temperature variations, all displayed in immediate juxtaposition to the relief model.

There are other large-scale models representative, in aim at any rate, of types of country, scenes in agricultural areas, and similar subjects. Such a form of exhibit necessarily makes serious demands on floor and wall space, is relatively expensive, and even at best (and two excellent models are included) can be only very generally and vaguely true to facts. At their worst such models are deplorable. One wonders what real conception is gained from such a model as that of the pastoral scene, which is not definitely characteristic of New Zealand, and might almost equally well have appeared in certain other courts. In general, and from many different points of view, the advantages of models of this type over a well-executed photographic illustration are slight, as is appreciated immediately if one balances a possible increased effectiveness over against the truer detail and easier production and display of the pictorial representation. The picture frieze shown in this gallery, moreover, although necessarily somewhat "skied," is unusually attractive, and the majority of subjects, though not all, are well selected.

In considering the exhibition of actual products one comes, of course, to the real core of the matter. Cabinet cases of the usual type show each a particular product at various stages of its utilization and give explanatory notes. The value of such cases is various: some are perhaps better suited for a commercial purposes display; others are of definite geographic worth. But in connection with even the best one feels strongly the lack of distribution maps and diagrams. This criticism, moreover, is applicable to the whole exhibition, and if the galleries are to serve in any sense as aids to the serious teaching of economic geography, and are to offer opportunity for a proper appreciation of the characteristics of production, it is important that this lack should be remedied. Fortunately it is comparatively easy and inexpensive. Small-scale maps indicating the chief areas producing single commodities are, it is true, affixed to most cases, but these are merely locational, and cannot be correlated one with the other. Nowhere does a series of illustrations appear. Yet for all the major items of production these should be given, and should include records, for example, of the relative importance of

the chief products under average conditions of production. As it stands, it would be quite possible for even a careful observer to leave the exhibition without the least appreciation of what were the most vital elements of the country's trade. The bases for such comparative illustration must of course vary in particular examples: money values, however, as sometimes introduced here, are clearly not always suitable as a base, especially for commodities whose value is naturally fluctuating or artificially controlled. And this is the case of several leading New Zealand products.

Representations of the status of the area in world trade with regard to the chief commodities are also required, and illustrations of the rise or decline of the area in this respect. Again, a matter of even more final importance, illustrations of the distributions of the products are wanted. With all the recent attention to Empire trade, some indication of the proportions received by Great Britain, and some comparison of these with those of outside areas are desirable, even if only for the opportunity afforded for driving home a realization of the growth of competition and the need for increasing attention on our part. As it stands at present, again, the intelligent observer may conceivably leave without any definite idea of the essential nature of the trade relationships between New Zealand and Great Britain. But these trade relationships are in causal connection with other forms of social and economic relations, the realization of which represents one of the ultimate objects of such exhibitions. Fortunately, suitable illustration is simple. In comparison with such, the mere multiplication of specimen products seems of little value. This is particularly true with regard to some products, where differentiation between the specimens shown really demands detailed and specialized knowledge of the matter, opportunity for close examination and handling of the product, and more constant and expert guidance than could possibly be provided. Thus, it is suggested, certain cases of small specimens of mineral wealth or forest products should give immediate place to further representation by some means or other of the salient characteristics of trade conditions and relations.

Such considerations lead naturally to those of internal and external communications, and these also apparently have received slight attention up to the present. To the mere representation of railways on the relief model should be added illustrations of the direction of movement of the chief commodities, the volume of trade along main lines, the ports of export and receipt, distinctive features of the trade of the leading ports, etc.—all matters of such fundamental importance and such obvious inter-relations that one's only excuse for thus enumerating them is that they have certainly not been adequately recognized in the scheme. Elaborate diagrams are of course not intended, the production in clear display of such being probably an unpractical proposition, even were there not the root difficulty that in proportion to their accuracy they

would need constant alteration and correction. But simple generalized illustrations, as graphic as may be, are certainly possible and essential.

Another omission becomes apparent when one turns to the study of settlement: it is generally true that there is no attempt made to show population conditions. Yet a country such as this with, on the whole, well-cut "edges" to its natural divisions, offers excellent opportunity for simple representation of the control of population distribution by physiographic conditions, or for tracing variations in population density, according to time interval or space relation. When, moreover, questions as to the emptiness of parts of the Empire, and projects for the redistribution of the Empire population are matters of such constant and everyday expression that references to them become platitudes, it is imperative to offer wherever possible a certain amount of authentic—and corrective—knowledge. General "density" maps or symbolic maps of selected districts, constructed in accordance, for example, with De Geer's plan, would be of real benefit. B. HOSGOOD.

THE FIRST WESTWARD VOYAGE FROM EUROPE TO JAPAN, 1598–1600

De Reis van Mahu en De Cordes door de Straat van Magalhães naar Zuid-America en Japan, 1598–1600.— Uitgegeven en toegelicht door **Dr. F. C. Wieder.** (Werken uitgegeven door de Linschoten-Vereeniging, XXI., XXII., XXIV.) The Hague: Martinus Nijhoff. 1923, 1924, 1925. 10 × 6⅜, pp. xv. + 319; xii. + 119; iv. + 231. *Illustrations, Maps, and Folding Tables. Price (to members) 12 fl. each volume.*

ON 27 June 1598 there sailed from Goree, equipped at the cost of certain merchants of Rotterdam, a little fleet of five Dutch vessels: the *Hoop* (Hope), the *Liefde* (Charity), the *Geloof* (Faith), the *Trouw* (Fidelity), and the *Blijde Boodschap* (Good Tidings—later *Flying Hart*). As Admiral in command of this assemblage of the cardinal virtues went Jacques Mahu (*Hope*), with Simon de Cordes (*Charity*) as his second-in-command. Their objective was the Pacific, and their route lay *viâ* the Strait of Magellan.

As a trading adventure, the voyage was a disastrous failure. Mahu, a marine Fabius Cunctator, spent three months in reaching the Guinea coast, where he died. De Cordes, equally impetuous, took over six months more to arrive at Magellan Strait, where, in spite of several opportunities to press on, he decided to winter—in which high adventure he expended most of the fleet's provisions and lost, through hardship and privation, upwards of 120 men. On 3 September 1599 the fleet, its number increased to six ships by the building during the winter of a small sloop, the *Postillon*, at last reached the Pacific, only to be immediately dispersed by a storm, and that so thoroughly that, with one or two temporary exceptions, none of its members came again into company. The *Hope* made for the appointed rendezvous, the island of Santa Maria, off Chile, before reaching which De Cordes and twenty-three men were killed on the mainland by the natives. On arrival she found the *Charity*, which had touched at Mocha (also off Chile), where De Cordes' second-

in-command, Van Beuningen, and twenty-seven men had met with a similar fate. Both ships then made sail for Japan, where the *Hope* arrived with twenty-four men all told, out of an original complement of 130. Most of the survivors ultimately made their way back to Europe, but the ship was retained by the Japanese, together with her pilot, the famous William Adams. The *Charity*, which had parted company with the *Hope* in mid-Pacific, was never heard of again, and the same tale has to be told of the *Postillon*. The *Good Tidings* found her way to Santiago, and was there seized by the Spaniards. The *Faith* and *Fidelity*, in company, turned back to shelter in the Strait, but the latter was blown from her anchorage a few days later, and after some adventures on the coast of Peru crossed the Pacific to the Moluccas, only to fall into the hands of the Portuguese. The *Faith*, under Sebald de Weert, set her course for Europe, and after falling in, before getting clear of the Strait, with a second fleet of four Dutch vessels under Oliver van Noort, which had sailed a month later than Mahu's, and whose commander was destined to become the first Dutch circumnavigator, entered the South Atlantic. Incidentally re-discovering the Falkland Islands *en route*, she reached Goree safely on 13 July 1600, the only ship of the five to return. She had been absent two years and sixteen days, a time which, as Burney severely but justly remarks, " had been greatly misemployed." In all, out of five ships and upwards of five hundred men, one ship and some fifty men made their way home empty-handed.

Historically, however, this ill-fated expedition was of great importance. Its units were the first Dutch vessels to sail through Magellan Strait, two of them were the first of that nation to cross the Pacific, and one, the *Hope*, was the first, not only of Holland but of any nation, to reach Japan by a westward route. Moreover one member of its *personnel*, Jan Outghersz, pilot of the *Faith*, has a special claim to remembrance, since he was the author of the first reliable chart, with accompanying sailing directions, of the tortuous and wind-swept highway to which Magellan gave his name, and which was long regarded as the only entrance to the " South Sea."

Several partial accounts of this celebrated expedition have appeared at various times, both in its own day and later (an excellent one, compiled from various sources, is to be found in Burney, vol. **2**, pp. 186–204), but none is very complete, and all have long been out of print. Thanks to the Linschoten Society, however, and to Dr. F. C. Wieder, who has edited the work, geographers have now been put in possession of a most valuable collection, in three volumes, of original documents relative to the doings of Mahu's fleet, carefully compiled, fully annotated, and supplemented by admirable disquisitions upon the various topics of principal interest.

The first volume deals with the events of the voyage—the preparation and manning of the ships, their adventures, and their varied fates. Beginning with all available data relating to the merchants who undertook the adventure, the provision of the ships and stores, and the composition of the *personnel* (including nominal lists and brief biographies of all the men who are known, by name, to have taken part in the expedition), it proceeds, after giving a short list of the correspondence exchanged between the best-known of its various captains, Sebald de Weert, and his family, and a collection of passages reprinted from the works of contemporary Dutch, French, and German historians who have given an account of the voyage, to reproduce in full the journal of Barent Jansz, barber-surgeon of the *Faith*. This journal (originally published by Zacharias Heyns, of Amsterdam, in 1600) is much the fullest account of the

voyage, by one of its members, which has survived. After the dispersal of the fleet, however, Jansz' narrative was necessarily confined to the doings of his own ship, and particulars of the fate of the remainder are therefore added in the form of extracts from the journals and depositions of some of their survivors and from various authorities, including particularly, in the case of the *Fidelity*, Errazuriz' 'Six Years of Chilean History' (Santiago, 1881).

A question of great geographical interest has long been associated with the proceedings of the *Good Tidings*, commanded, after Mahu's death, by Dirk Gerritsz Pomp (*alias* "China") in succession to Sebald de Weert. In the 1622 edition of Herrera's 'History of the doings of the Spaniards in America . . .' there appeared, for the first time, the statement that this vessel, after the dispersal of De Cortes' fleet, had been driven southward by a storm to lat. 64° S., where she fell in with a mountainous snow-covered land resembling the coast of Norway. In consequence Gerritsz was generally credited, during the last century, with the first discovery of the South Shetlands and/or Graham Land—in fact, the earliest Admiralty chart of that region, published in 1822 from Bransfield's survey of 1820, contained a note specifically asserting this. Two depositions by members of his crew—Jacob Dircksz and Laurenz Claesz—exist, however, in the Hague Rijksarchief, and these documents, to which attention was first drawn by Mr. E. S. Balch in his 'Antarctica' (Philadelphia, 1902), and which are also quoted by Dr. Wieder, make it clear that the *Good Tidings* did not cross 60° S., although Claesz states that he "went in March (1603) to 64 degrees, where they had much snow . . ." on board a Spanish vessel. He makes no mention, however, of any discovery of land, and the origin of the statement in Herrera remains an unsolved puzzle. But although the connection of Gerritsz with Antarctic discovery has proved fabulous, he retains some claim to distinction as being the first Dutchman to visit Japan (in 1585), and it is chiefly on this account that a previous volume issued by the Linschoten Society (No. IX.) has been devoted to his career, and incidentally to clearing up the confusion caused by his possessing a brother of the same name, who also sailed in the *Good Tidings* but, fortunately for the historian, was killed at Santiago.

The illustrations to the first volume include the original ten woodcuts published with Jansz' journal, amongst them being a most amusing portrait of the author, standing at gaze in the foreground of a rugged and barren landscape (intended to depict the scenery of Magellan Strait), while surrounded by the local fauna, comprising not only a puma and a wolf, but also a lion, a gryphon, a cockatrice, and a seven-headed and ten-legged dragon. Four woodcuts are also reproduced from De Bry (re-drawn and embellished versions of those in the original edition), together with an excellent copper-plate portrait of Jansz (without menagerie). There are also two other interesting old woodcuts—a view of Rotterdam showing the five ships lying off it, published in 1599, and a portrait of Heyns, Jansz' publisher. At the end of the volume is a modern chart of Magellan Strait, together with a small track-chart showing the outward route of the fleet as far as the strait, and the homeward track of the *Faith*.

The second volume is devoted to a very elaborate and scholarly investigation of the early cartography of the Magellan Strait region. After briefly discussing the passages made by Magellan, Drake, and Cavendish, and the resulting charts, it gives full details of the work of Outghersz, and reprints in full his sailing directions for the strait (which, like Jansz' journal, were published by Heyns), together with the ten small charts inserted in his text. Dr. Wieder

also gives a detailed catalogue of 152 sixteenth-century charts depicting this region, with particulars of the works, if any, in which these have subsequently been reproduced. Furthermore, after enumerating the thirteen navigators who sailed through the strait on fourteen occasions (Gamboa traversed it twice) between 1520 and 1600, he enters into an elaborate investigation of the descriptions left on record by them, and gives a comparative table showing 180 points on the modern chart of the Strait which can be identified from the descriptions given in one or more of these early accounts.

The illustrations accompanying this volume include a number of reproductions of early charts, or portions of charts, showing the strait, together with a facsimile reproduction of Outghersz' chart as given in the Mercator-Hondius atlas of 1606 and a composite chart showing, to one scale and in their correct relative situation, the ten small charts illustrating Outghersz' sailing directions. A modern chart of the strait is also included for comparison.

The third volume is devoted to recording and presenting data connected with the activities of that portion of the expedition which succeeded in reaching Japan, including a summary of the commercial and political conditions obtaining in that country at the time of the *Hope's* arrival in 1600. Considerable space is, of course, devoted to the career of William Adams, and Dr. Wieder reprints the two simple, rugged, and pathetic letters, well known to readers of Purchas, which were written by that "Kentishman, born in a town called Gillingham," from his gilded cage at Ferando, to his "Loving Wife," and to "my unknowne frinds and countri men." He also prints a third letter of great interest, the only one known to have been written by Adams in Dutch, which is preserved in the Hague Rijksarchief. As a supplement to these, he gives a very interesting collection of letters written by some of the early Dutch traders in Japan.

A couple of pages are devoted to a verbatim reproduction of a letter written to the *Honolulu Advertiser* in December 1922 by Bishop Resterick, advancing "strong grounds for believing" that the *Hope* and *Charity* sighted Hawaii in 1600 in the course of their voyage towards Japan. The theory is not absolutely untenable, but the evidence advanced in its favour is very far from convincing.

An elaborate bibliography and an index to the complete work conclude the volume, which is not so profusely illustrated as the two former, there being, in view of its different scope, no necessity for such treatment. It includes, however, as a frontispiece, a reproduction of part of Linschoten's chart, showing Japan and Formosa, and also contains the same modern chart of Magellan Strait which accompanies the first and second volumes.

The Linschoten Society and Dr. Wieder are both to be congratulated upon the production of yet another important and exhaustive work, of great interest and permanent value. R. T. G.

ICE AGES

Ice Ages: Recent and Ancient.— A. P. Coleman, M.A., Ph.D., F.R.S. London: Macmillan & Co. 1926. $8\frac{1}{2} \times 5\frac{1}{2}$, pp. 296 + xliii. *Eight Letterpress Maps and Fifty-one Illustrations.* *17s. net.*

IN this book Prof. Coleman states concisely the results of his life-long study of glacial phenomena in rocks of all ages in all countries. He writes with a wider personal knowledge of the subject than any one else can

claim, for he has had under his own observation most of the principal exposures of such rocks in North America, South America, Western Europe (including Spitsbergen), India, South Africa, and Australia. Consequently he is able to adorn his descriptions with personal reminiscences, which give life to his narrative. His studies have been the object or excuse for many arduous journeys which have led him often into the hotter regions of our present lands, where the conditions now are in the sharpest contrast with those which must once have ruled; and he notes how impressive it is to observe the work of old ice-sheets while enduring the heat of the tropics or sub-tropics.

It is surprising how much information the author has contrived to pack into some 300 pages, of which about 50 are allowed to pictorial illustrations. Beginning with a short statement of the general character of the geological evidence for former vicissitudes of climate, he deals next with the broad features of the Pleistocene or latest glaciation in North America, where he is at home, and then in all other parts of the world. From this best-known ice age, which has furnished the basis for our recognition of the earlier glaciations, he works backward in time, stating briefly the scattered and in some cases inconclusive indications of local ice-action in various countries in Tertiary and Secondary formations (pp. 77–88). Then he reaches the most perplexing and best authenticated of all the old glaciations, that of Permo-Carboniferous and Carboniferous times in India, South Africa, Australia and South America, on which he dwells lovingly in five or six chapters. It is the growth of knowledge of this great Permo-Carboniferous ice age which has most effectively warned geologists how imperfect their interpretation of the past still is, and has given rise to a crop of new and questionable speculations that will carry important geographical as well as geological conclusions if established.

While dealing frankly with the evidence in all doubtful cases and making due mention of divergent opinions, Prof. Coleman sweeps as much as possible into his Glacial net, and casts widely for bouldery conglomerates of all ages. This predilection, apparent in many passages, is well exemplified in the short chapter (xi.) on the indications of ice in Devonian, Silurian, and Ordovician times, where at least some of the instances referred to are not usually supposed to require the agency of ice. It is otherwise, however, with the still older icy episode at or just before the beginning of the Cambrian period, dealt with in chapter xii., for which there is unchallenged evidence in several regions, particularly in Australia. The descriptive part of the book closes with a chapter (xiii.) on glaciation in Huronian and perhaps earlier times, the most ancient known, of which he speaks with special authority, having himself been the chief investigator and exponent, and having still to overcome some scepticism among Canadian geologists. His own conclusion is that in the case of the Huronian "the area of glaciation is so great that one must assume a very important refrigeration, one to be classed among the first four in severity" (p. 239); and he points out how "the finding of these evidences of ancient glaciation has revolutionized our ideas as to the origin and history of the world, and has rendered improbable the theory [of a gradually cooling globe] which was accepted by astronomers and geologists a generation ago as the natural starting-point in the evolution of the planet" (p. 240).

Among the many important results of these recurrent epochs of glaciation, Prof. Coleman lays stress upon their probable influence on the life of the Earth and its evolution. He shows what radical changes in animal life have accompanied the great ice ages, and notes that the Permo-Carboniferous glaciation wrought a transformation in almost every branch of animal and plant life.

Half playfully he adds, " But for this rude interruption possibly gigantic insects with large brains might have led the world intellectually in later times instead of vertebrates. Knowing how efficient and ruthless are the instincts of our tiny modern insects the thought is somewhat appalling. Their line of advance, so far as size is concerned, seems to have been cut off by the advent of frigid conditions : and the next group of animals to develop mightily was the reptiles. If the small dip in temperature which occurred in the Eocene had not halted the progress of the cold-blooded saurians and destroyed the largest and most advanced of them, who knows that the dinosaurs and pterodactyls might not have led the way up to the present instead of warm-blooded, well-clothed mammals and birds ? Ice ages have occasioned far-reaching and salutary changes in the world's population as judged from the human point of view " (pp. 188–9).

The book ends with a crisp discussion of the problems as a whole (Part III.), in which the many and diverse ideas promulgated to explain them are passed under review. These are classed as (i) *Geological theories ;* including the supposed cooling of the earth : effects of changes of level by elevation or depression of the land-masses : the supposed drift of continents as propounded by Wegener and others : changes in ocean currents ; and (ii) *Atmospheric and Astronomic theories ;* such as the effects of carbon dioxide and of volcanic dust in the atmosphere : changes in the eccentricity of the Earth's orbit (Croll) and of the angle of its axis ; shifting of the axis ; changes in the sun's radiation ; and in the temperature of space. In respect to all, Prof. Coleman finds, like most field geologists, that none carries conviction. He says (p. 282) : " It may be expected that the present writer, after pointing out defects in all the previous attempts to solve the tangled problems of glacial periods, should propose something which he considers more satisfactory. This I do not feel competent to undertake. During many years of study of glaciation I have hoped to find a solution of the difficulties in several theories at different times, but have always encountered some point where they failed." And in a concluding paragraph he gives his opinion that no single cause is likely to yield the solution, but that it may yet be found in some combination of astronomic, geologic, and atmospheric conditions involving a rare conjunction of general and local causes. G. W. L.

THE OFFICIAL TEXT-BOOK OF SURVEYING

Text-book of Topographical and Geographical Surveying.— Colonel Sir Charles Close and **Colonel H. St. J. L. Winterbotham.** Third Edition, 18th thousand. London : H.M. Stationery Office. 1925. 10½ × 7½, pp. vi. + 366. *Maps, Illustrations, and Tables.* 15*s. net.*

THERE are few text-books which are unique of their kind and indispensable : but this may be reckoned one. When it appeared first in 1905 (at the lamented price of 3*s.* 6*d.*) it became at once the standard book for British surveyors in the field. In 1913 a second edition, much enlarged and improved, inaugurated its tenth thousand : and the eighteenth thousand begins with yet a third edition, dated 1925, but published in March of the present year. Though it now costs fifteen shillings it is still a very cheap book for the time, with its 248 pages of text and elaborate computation forms, 80 pages of tables, 12 appendices, and 30 plates, including a dozen maps printed

in colour and two star charts. The new edition is in the familiar and admirable scarlet cover. The text has been compressed by removing the leads from between the lines, but is otherwise the same in style and a great part of it from the type of the second edition—a modern-face type which is the least admirable feature of the book, and especially unsuited to the tables. It is time that H.M. Stationery Office accepted the advice of their own Blue Book on Government Printing and adopted old style numerals for tables, as all wise printers have long since done.

The book has always been in a sense a compilation, for it was the policy of its original author, then Major C. F. Close, to base each section upon the knowledge of an officer with the latest experience in the field. The same policy has been followed in later editions; the prefaces are full of careful acknowledgments: yet the book as a whole becomes in each edition increasingly homogeneous, with the contributions successfully moulded into shape. As for the respective shares of the principal authors, we may occasionally find a passage to be attributed confidently to one or the other: but this is rare, and the book as a whole is a well-balanced, slightly conservative, guide to the combined experience in survey of their distinguished corps.

Since 1913, when the second edition was published, the Royal Engineers have served in every field of war, assisted to draw the treaties of peace, faced the problems of after-war reconstruction of all survey services, and actively engaged in the developments of method and instrument that have been so rapid. 'Tis difficult at such a time to decide what may safely be scrapped, and to select from the crowd of new instruments and methods those which have established the right to be included in a standard text-book designed not so much for the specialist and the experimenter as for training sound surveyors on canonical lines. Well-established methods are not to be too hastily discarded, nor the latest "jim"—if that is the way to spell a word which we have often heard but never seen written—too hastily adopted.

Take first the methods that have disappeared from the third edition. The chief are the absolute methods of determining longitude by occultations, by moon-culminating stars, by lunar photographs (Hills' method), and others. The antiquarian astronomer of a century hence will admire the elegance of the method devised by Col. S. C. N. Grant, R.E., and perfected by Dr. Crommelin, for predicting the local circumstances of an occultation: but the boundary surveyor in the field, receiving standard time signals by radio telegraphy almost hourly, may dimly recall without regret a sentence in the second edition: "In Northern Nigeria, in 1903, the Anglo-French Boundary Commissioners, with two sets of instruments at their disposal, waited two months at one place before a set of three occultations was obtained." Absolute methods of finding longitude are dead; and we suspect that a fourth edition of the Text-book will discard the already obsolescent methods by exchange of telegraphic signals over wires and by transport of chronometers.

The authors admit the reluctance with which they have abandoned the well-known P, Q, R, S, T tables for differences of latitude, longitude, and reverse azimuth, based on Puissant, in favour of the "mid-latitude" formulæ, with Clarke's as an alternative in Appendix D. There was indeed a peculiar charm about Puissant, with his continual successive additions that reached the desired result in a mysterious way; we leave him with regret. The new tables, like the old, stop short at latitude 60°, and University expeditions which prefer 80° have still a grievance.

As further signs of the times we note the disappearance of the Y-level in

levelling ; of the water-level in contouring ; of Albers' and Clarke's projections ; and of photo-etching in reproduction. But the disappearance of the expressions for the error per mile of lines of levels at the end of chapter x. is perhaps unintentional.

Turn now to the sections that are introduced in the third edition. The chapter " Surveys in War " has a new section, " I. Under European Conditions," which is full of interest but rather brief, and says nothing at all of flash-spotting and sound-ranging, which formed so large a part of the work of the Field Survey Battalions in the Great War, of which a brief historical account would scarcely have been out of place, though recent developments must necessarily be excluded.

The chapter on Triangulation has an interesting addition in the semi-graphic co-ordinate computation for intersected points.

The new chapter on Photographic Surveying is, it must be confessed, a little disappointing. It begins with " I. Ground-Photo-Surveying : (*a*) With an ordinary camera fitted with levels," and gives a brief account of the Canadian method described in Deville's work dated 1895. The method " (*b*) Stereoscopic Survey on the Ground " is described shortly as " a method which, in Great Britain, has not yet emerged from the experimental stage," which is unfortunately literally true, and yet hardly fair to the Britons who. years ago obtained successful results in Fiji and on the Pamirs and in the Tien Shan with instruments a good deal better than ordinary cameras fitted with levels. To ignore the existence of photo-theodolites is indeed surprising ; and while it is true that work with the ordinary stereo-comparator is excessively slow, it is at any rate much quicker than to work without one in the Canadian manner, if only because there is no trouble at all in the identification of corresponding points.

Again, we read that " stereo-photo surveying . . . is not very likely to be valuable in small-scale mapping, since the errors increase as the square of the distance of the object mapped "—a theorem not so general, we think, as is made to appear. Does it not apply only to measures of extreme distances from a base of predetermined length, and not to measures from bases suitably chosen for the scale ?

The section on Air-Photo Surveying is more encouraging, though almost confined to the elementary methods extemporized during the war. It admits the existence of automatic stereoscopic plotters, but takes a rather gloomy view of them. " The cost, size, and weight of these machines are such as to forbid their general use, but they are even more likely to find a real, if limited, utility in the future than the stereoautograph. . . ."

With all respect to the high authority of the authors, the reviewer ventures to predict that these forecasts will be proved wrong, and that a future edition of the Text-book will say something like this : " The old-fashioned theodolite is in most triangulation, whether of the first or second class, superseded by the photo-theodolite, and a round of angles is always supplemented with a round of photographs. With a superposed accurate rectangular graticule and a very simple measuring machine, all intersected points required immediately by plane-tablers, or for air survey, can be quickly determined from these plates, with the trigonometrical heights. The method is especially suited to reconnaissance in mountainous country, where the heights are difficult, and are dead ground to the topographers in the valleys.

" Automatic stereo-plotters, though now much smaller, lighter, more compact, and cheaper than the first cumbrous models of the '20's, are too com-

plicated for use in the field. But each Survey Department has now a stereographic laboratory at headquarters, with a permanent technical staff. For systematic small-scale mapping of high and difficult country the normal procedure is to plot and contour automatically the high ground from pairs of plates taken on converging angles from neighbouring trig-points. Prints of sheets are then returned to the field, and the dead ground in the deeper valleys is completed by plane-table, or, when funds and circumstances permit, perhaps by air photographs.

"It should be clearly understood that ground photographs taken at triangulated stations give much higher accuracy than air photographs from points in space determined by resections which can never be geometrically strong. Hence the map should be built up as far as possible from ground-photographs, and the expensive and difficult air-photography used as an auxiliary."

So much for an anticipation of, let us say, the fifth edition. Now to return to safer topics: An important new chapter is that on the Prismatic Astrolabe, and its convenient equivalent, the ordinary theodolite fitted with Reeves' prismatic attachment. An excellent summary is given of the method of reduction elaborated by Dr. Ball and Mr. Knox Shaw in their well-known treatise, and Mr. Weld Arnold has contributed a fully worked example, whose conclusion the printer has a little obscured by bracketing the assumed preliminary values and the concluded results together as "assumed results" (p. 246). The graphical solution has the inestimable merit of showing at once the precision of the observations, and which, if any, is inconsistent with the others. It is not so well known as it might be that precisely the same method can be used for working up observations with the theodolite at varying altitudes; so that the time-honoured circum-meridians and east and west stars can be conveniently replaced by four or more stars chosen in azimuth as for the astrolabe, but without restriction to a precise altitude. Field astronomy thus acquires a beautiful flexibility, and achieves great economy of time. But to what purpose? "We must ask ourselves," says the Text-book, "under what conditions are refined latitudes required in topographical work, and the answer, in view of the existence of local attraction, is *never*." There is something to be said for substituting the word *always*. The discordances between astronomical and geodetic latitudes are so large that we must in future greatly increase the astronomical work, and aim at securing good (but not *unduly* refined) latitudes at every triangulation station; not only the geodetic stations along a narrow chain, but the second-order stations over the widest possible area. Only then shall we get any real knowledge of local attraction, which knowledge is not superfluous even to the topographer and is essential to the progress of geodesy.

Equally important to both is the vast improvement in field longitudes due to wireless telegraphy. The author of the entirely new section was unfortunate in his epoch: he wrote just before the signals of the B.I.H. were greatly altered, so that many of his details are already out of date. Apparatus for reception changes so quickly that perhaps he is right in confining his advice on instruments to the aphorism that "a wireless reception set to receive time signals should conform to the latest ideas on design." But one may easily exaggerate the notion that a special design is required to suit a particular job, and that there is no such thing as a "general utility" set. Bordeaux and Nauen can be heard over an immense range with a straightforward three-valve set with one stage of H.F. amplification and one of low. What experience we have in the Instruction Room of the R.G.S. shows that a very real difficulty

is that one cannot judge in England how good a set may be in Central Africa. Loose-coupled secondary circuits may be unnecessary in the distant field. But unless you have them in Kensington you may tune to 19,000 metres and hear nothing but a too-familiar transmission on 365. Thus it comes about that the receiving set bought for the Society more than two years ago from a leading firm, and at that date their best general utility set for all wave-lengths, is perfectly effective; while a recent set by the same makers especially designed for time signals, and proved very efficient in Sumatra, is of little use in London with a big aerial because it has no loose-coupled secondary, and one cannot keep out the broadcasting.

Apart from this avoidance of the instrumental outfit, the section is a very useful account of experience based evidently on the work of the boundary commission on the western frontiers of the Sudan. The author exaggerates, we think, the directive effect of the ordinary single-wire aerial: the cosine law is surely applicable only to the frame aerial. And he puts too mildly the recommendation of heterodyne reception of continuous wave, as the system least liable to jamming: it is the only system for receiving the long-range signals from Bordeaux and Nauen and Washington (Annapolis). Interference of long-wave stations that cannot be tuned out, such as Rugby with Nauen, is so bad in England that the pupil in survey is discouraged; and there is all too little definite information as yet from parties in distant fields. May one hope that enthusiasts all over the world will equip themselves with the necessary coils and log systematically all time signals they can pick up? It would make a valuable contribution to an aspect of "reaching out" that has been much neglected.

Photographic survey and radio-reception are in their youth, with futures still uncertain, but open to discussion. No text-book can treat them with the confident dogmatism appropriate to well-tried methods: and no reviewer can venture to do more than to think aloud the alternatives and occasional doubts that arise in a first examination of the new material. The present reviewer owes all his interest in the great subject of Survey to the inspiring instruction Major Close gave him at Chatham in 1904, when the first edition of the Text-book was nearing completion. It is a pleasant duty more than twenty years later to felicitate Sir Charles and his collaborators on the appearance of this third edition, destined to consolidate its position as the one book indispensable to all students of survey. A. R. H.

REVIEWS

EUROPE

The Dublin Civic Survey Report, prepared by **H. T. O'Rourke** and the Dublin Civic Survey Committee. Vol. II. of the Publications of the Civics Institute of Ireland. The University Press of Liverpool and Hodder & Stoughton, Ltd., London. 1925. 13 × 10, pp. xx. + 150, *Ten Maps in Colours and* 66 *Plates.* 21*s.*

In the Introductory Statement to this volume the writers state: "A civic survey is the statistical and graphical representation of things as they are in a community." This sentence indicates the scope of this volume. It attempts by maps and illustrations, accompanied by explanatory text and statistics, to give a full and accurate account of the metropolitan area of Dublin as it is to-day. While the compilers hope and believe that this survey will be a basis

for the replanning of the area, they do not here attempt to work out any plans for future developments.* And only in the concluding paragraphs, with their excusable rhetorical flourishes, does the report depart from a sober statement of facts.

Like many other cities, Dublin has grown since the mediæval period without any systematic guidance or plan: the industrial cities of Great Britain show the same lack of plan; and a comparison of the state of things described here with that in such cities as Dundee, Leeds, or Bristol does not support the view that a large part of Dublin's difficulties are due to the relations between Ireland and Great Britain, except for the destruction of some parts of the city in 1916 and 1922. The writers are nearer the truth in saying (p. xvii.), ". . . the difficulties and costliness of civic administration can be ascribed to . . . blind and wasteful development."

The survey was conducted by the method of circulating carefully planned questionnaires, supplementing the answers to these by the direct investigations of a number of workers, and then analyzing and tabulating the results, which where possible are expressed in maps and diagrams. These results are set out in seven sections devoted respectively to Archæology, Recreation, Education, Hygiene, Housing, Industry and Commerce, and Traffic. And an Appendix summarizes some existing Town Planning Proposals for Dublin. The section on Housing particularly illustrates the characteristics of the distressful city, which are largely due to its stagnation during the latter half of last century—the population increased up to 261,700 in 1851 and then decreased steadily to 245,001 in 1891, since when it has risen to 333,000, partly by extension of the city boundaries. The very bad condition of the housing is also ascribed in part to the fact that the city is more commercial than industrial, and hence that its working class includes a very high proportion of unskilled labourers, and comparatively few of the skilled artizans of the industrial cities. On p. 81 it is stated that " as a manufacturing centre Dublin is to-day comparatively negligible." This seems to be an exaggerated statement; for the section which it introduces contains details of many industrial undertakings in the area which show a considerable total, although no single one can be regarded as a really large industry. The Free State has not yet taken a Census of Production, and therefore the information here is incomplete.

The volume will form a valuable record of the state of Dublin in the early years of the Irish Free State, and a stimulus to civic surveys elsewhere. It is well printed, with very few printers' errors, and its plans and maps are very clear. It is however too weakly bound, and it has no index. The last lack is a serious defect in a work intended for reference, and containing so many statements of somewhat disconnected facts. C. B. F.

The Story of Ravenna.— Edward Hutton. Illustrated by **Harald Sund.** (The Medieval Town Series.) London: J. M. Dent & Sons, Ltd. 1926. 7 × 4, pp. ix. + 326. *Sketch-maps and Illustrations.* *5s. 6d. net.*

Rome.— Gabriel Faure. (The Picture Guides.) London: The Medici Society. 1926. 8 × 6¼, pp. 150. *Illustrations.* *7s. 6d. net.*

In his opening chapter Mr. Hutton explains very clearly the factors to which Ravenna owed its importance. He does not explain so concisely the causes of its decline, though these may be gathered from the detail of his later chapters. At first Ravenna was the link between Rome and Cis-Alpine Gaul, or the valley

* Plans for the future were discussed in vol. 1 of the Institute's Publications (see review in *Journal*, 62, p. 303).—ED. *G.J.*

of the Po: when Roman authority was completely established there, Ravenna's importance declined, only to rise through a variety of historical events to greater heights as the outpost of Byzantium in Italy. Overshadowed once more by Rome, and deserted by the sea, Ravenna remains a storehouse of architectural treasures of the fifth to the eighth centuries, of Byzantine and Romanesque styles, hardly touched by the developments of the Middle Ages and Renaissance. Of this and many other equally interesting subjects, Mr. Hutton has much to relate in a book which is a model of its kind.

The author of the Guide to Rome has not, of course, attempted to equal the thoroughness of Mr. Hutton's book, and its chief feature is the numerous illustrations. Rather disheartened by the magnitude of his subject, he has simply set down brief descriptions of several walks which cover most of the monuments of classical, mediæval, and Renaissance Rome, and has recorded the feelings of others, poets and artists, on first viewing the city.

Two Vagabonds in Sweden and Lapland.— **Jan and Cora Gordon.** London: John Lane. [1926.] 9½ × 6½, pp. x. + 323. *Illustrations.* 12*s.* 6*d. net.*

After the Balkans, Spain, and Languedoc, the authors have made their way leisurely through Sweden and Lapland. As before, without apparent effort but with directness and an economy of effect, they are able to assemble illuminating, though often trivial, incidents into a narrative reflecting their own humour, sympathies, and characteristics. In their own words, they belong to that class of travellers styled "tavernists," in contradistinction to "templers"; consequently in their pages companions and chance acquaintances take first place, and show places are not so much avoided as ignored. The picture they present of the Swedes is that of a hard-working, stolid, and good-natured peasantry becoming transformed by cosmopolitan commercial ideals. Before this transformation rural life is passing away, and with it its genuine characters, and its craftsmen who gave expression to that "old and beautiful sense of the interior" typical of Swedish homes. The chapter devoted to their arts, particularly to folk-music and to cottage paintings, is therefore of special interest. In Lapland the actual details of the inconveniences and chances of travel become more prominent, but these serve to bring out the character of the country, and information on the Lapps is not altogether withheld. One of the merits of these vagabonds is that they rarely dwell unduly upon their own hardships on the way, and have a proper notion of the exact value of their achievements.

Isles of Greece.— **Anthony Dell.** London: Geoffrey Bles. 1926. 10½ × 7½, pp. xii. + 226. *With Twenty-four Photographic Plates.* 30*s. net.*

This is a readable, observant, well-produced narrative of a voyage from Brindisi to Rhodes on an Italian steamer, then up to Smyrna, and back to Brindisi, with railway excursions to Athens, Mycenæ, and neighbouring sites, and some pleasant days ashore in Corfu and Rhodes. The collotype plates are delightful as pictures, but a little too dreamy as to focus, to tell all that was to be seen, a real defect in a country where "atmosphere" of the kind beloved by artists seldom exists. Mr. Dell has the knack of making fellow-passengers communicative, and, like Herodotus, does not always believe what they tell him; he has, however, set down a few things without comment which can hardly have been intended seriously; for example, about the abundance of gold in Castelorizo (p. 120). Of the state of affairs in the Greek islands under Italian administration he was naturally unable to discover

much beyond the erection of new buildings in Rhodes. The tale told him about uninhabited houses in Kalymnos (p. 78) was true, but not the whole truth. J. L. M.

Motor-cruising in France.— Capt. Leslie Richardson. London: Geoffrey Bles. 1926. 9 × 5½, pp. 286. *Illustrations.* 16*s. net.*

Capt. Richardson is the possessor of a 26-foot motor boat with auxilliary sails, and in this unpretentious narrative he describes various trips between Brittany and the Riviera by way of the "Canal des deux Mers." The book is calculated both to encourage and to enable others to follow in his track, for his trips have been successful and obviously enjoyable.

ASIA

Beyond the Bosphorus.— Lady Dorothy Mills. London: Gerald Duckworth & Co. 1926. 8⅛ × 5½, pp. 224. *Portrait and Illustrations.* 15*s. net.*

The authoress of 'The Road to Timbuktu,' whose portrait adorns the Frontispiece, here leads us to new and strange adventures in Angora, Syria, Palestine, and 'Iraq. The prelude tells of a beginning by no means auspicious, but introduces us to a spirit which, rising above all discomforts—some practically self-inflicted—conducts the writer to the opening scene in Anatolia. Here her greatest adventure was her being privileged to witness from a balcony of the Forum the sitting of the National Assembly of the now hatted and beardless Turks. The "Drama of the Taurus," the best-told romance of the book, concerns a Russian ex-Prince turned hermit in the mountains of Asia Minor. Of Adana there is little good said; visits there going and returning appear to have been equally uncomfortable for a woman travelling all alone. "The Holy Land," which occupies the largest section of the book, has been so much described recently that it must be difficult to write anything new, but the very full account given here of Lord Balfour's visit last year to Palestine is of genuine interest. "It was a theatrical *coup d'état* that to the Jew of Palestine crystallized and made tangible the half-baked dreams of centuries." "The greatest day that Jerusalem has known since Solomon laid the foundation stone of the temple," were words uttered in the author's hearing by a highly educated and cosmopolitan Jew, that famous first of April.

Regarding the Dead Sea the writer exercises a great deal of morbid fancy, and finds on the road to Es Salt much exaggerated peril. On the other hand, "Across the desert to Iraq" is a narrative, racily told, of real excitement. Indeed, it is for its adventures and thrilling incidents rather than its sober facts that the book can be recommended. E. W. G. M.

Thro' the Gates of Memory.— Betty Cunliffe-Owen. London: Hutchinson & Co. 1926. 9½ × 6, pp. xvi. + 267. *Two Illustrations in Colour and Sixteen in Black and White.* 21*s. net.*

This volume is much more than a mere journal of travel; it records in a delightfully bright and humorous way a number of stirring happenings in the Near East before the outbreak of war and immediately succeeding the Armistice. Part I. gives an interesting sketch of life in the British Diplomatic circle in Constantinople on the eve of war. The story is here re-told of the manner in which the Turks were precipitated into the war by naval action against Russia entirely unprovoked and done deliberately to make war inevitable, an act arranged by the Germans without consulting Djamal, Enver,

or other Turkish officials. The immediate and perilous escape of the British officials and others from Constantinople is here described.

Part II is an exciting narrative of a unique incident connected with the war in 'Iraq. Lieut.-Colonel Cunliffe-Owen was appointed by the G.O.C. in Chief in Mesopotamia to take over the control of a large refugee canvas city at Ba'qūba, some 20 odd miles east of Baghdad. This was an attempt to preserve the 50,000 souls, the last remnants of the Chaldean refugees, and later to restore them to their old homes north-east of Mosul. That the latter proposal—carefully organized as it was—was a dismal failure reflects no discredit on the leader or on those of our countrymen associated with him, who sacrificed time and health, and in some instances life itself, to help a people who seem to be entirely without the moral backbone necessary for the doing of their share. For an English lady to go through the experiences here given and to preserve health of body and so cheerful a spirit is no small achievement. She has put the public in her debt for the delightful way she narrates her experiences through all these varied vicissitudes—in the besieged desert camp, at Babylon, or, a refugee herself, in the Persian town of Kermanshah.

E. W. G. M.

Der Altai: Eine Physiogeographie.— Dr. Paul Fickeler, München. (Ergänzungsheft Nr. 187 zu *Petermanns Mitteilungen.*) Gotha: Justus Perthes. 1925. Pp. ix. + 202. *Mit* 7 *Tabellen,* 1 *Kurventafel,* 5 *Karten und* 14 *Abbildungen.*

This useful monograph is a careful summary of all the known investigations of the Altai region, the remote and difficult mountain country of Central Asia which forms one of the main tectonic factors of the continent. There is much yet to be learnt of this region, but already sufficient is known to justify the provisional geological and physiographical interpretation of its history which is attempted in this work. Its author has gone systematically through all the scattered literature, and from it has compiled an orderly account of its contents, and, to some extent, of his own deductions from them, classified, as usual in German works of this kind, under a regular system of headings and sub-headings. The main division is into " The Mongolian Altai " (Part I.), " The Russian Altai " (Part II.), and " The Geological and Morphological Development-History of the Altai " (Part III.). In the first two parts the subject-matter is arranged under the dominant headings (with many sub-headings) of 1, Geography; 2, Geology; 3, Climate; 4, The Ice Age; 5, Morphology; 6, The Plant-world. These headings will serve to show the scope of the monograph, which will appeal to all students of Asian geography and geology. The geological history of the Altai is long and complex, and is skilfully outlined by the author in Part III.; but as modifications in the interpretation of its structures have been introduced by each successive explorer, it is not to be expected that finality has yet been reached.

AFRICA

Sahara.— Angus Buchanan. London: Murray. 1926. 9 × 6, pp. xvi. + 302. *Sketch-maps and Illustrations.* 21*s. net.*

Capt. Buchanan crossed the Sahara from south to north, but he does not say much about the actual journey, which extended from Kano to Tuggurt in Algeria. His book consists of a number of graphic sketches of desert scenes, its inhabitants, oases and animal life. His account of the Bilma salt caravan, the great *Taralum* of the desert, which starts every year from the south-east

side of the Aïr mountains for the oasis of Bilma to obtain a stock of salt, gives a vivid picture of desert travel. A caravan of 7000 camels, stretching for miles, plunges into the Bilma desert, which is desert at its worst, an absolute sea of sand, destitute of the minutest object. Over this wilderness for 200 miles the caravan is led by one old experienced guide, on whose wonderful knowledge of the desert depends its life. The most travel-experienced men of the Taralum are sorely tried and wearied by the very long days, and heat of the merciless sun. Even Efali, the fine old guide, in the end had the appearance of a broken man, limping and stooping almost double, though at the start he had a trim nimble figure remarkable for a man of his age.

The description of the oasis of Fachi reads like a fairy tale. A town built wholly of salt, the walls constructed of salt blackened with dust and age, set as hard as concrete and rasping as broken glass. Strange as it may seem, the narrow streets and the construction of the houses within the walls offer no mean defence against the raiders of the desert, for within a moment's notice the whole town can be barred and buttressed, and placed, as it were, under lock and key.

The author has a good deal to say about the Tuareg, the "People of the Veil," whose characteristics, temperament, and mode of life are described. He distinguishes the bold, haughty, raiding, nomadic tribes, the true sons of the desert, from the sedentary inhabitants of the oases and mountain villages who employ negroid slaves to cultivate the soil, though the actual practice of slavery has ceased. He believes the whole future of the Sahara depends on the oases, and that the entire land will ultimately survive or go under according to the efforts they put forth. His hopes for the future, however, are not bright. "I see in the oases to-day," he says, "human life at a very low ebb. Human life that has been allowed to go to rot, because through the ages the Sahara has had no strong friends to reach out a hand and lift it from the 'Slough of Despond.'"

Capt. Buchanan is an experienced zoologist, and has a real sympathy for animals which is shown in his references to the camels of the desert, and especially the faithful animal that carried him throughout his long journey, and for whom he admits a warm affection. The parting of the master from his faithful companion, and the almost immediate death of the latter without any apparent cause, is a truly pathetic incident. The main object of the expedition was very successful, for 134 species of birds and 42 of mammals were collected in the desert, several of which were new.

Accompanying the expedition was a skilful photographer, Mr. Glover, and as a result the book is illustrated with a series of fine photographs, eighty-four in number, presenting an admirable picture of the desert from every point of view. The map provided hardly comes up to the same standard.

E. A. P.

The Wonderland of Big Game.— Major A. Radclyffe Dugmore. London: Arrowsmith. 1925. 10½ × 7½, pp. 288. *Sketch-map and Illustrations.* 25*s. net.*

A Naturalist in East Africa.— G. D. Hale Carpenter. Oxford: Clarendon Press. 1925. 9 × 6, pp. 187. *Sketch-maps and Illustrations.* 15*s. net.*

Since the beginning of the present century there has arisen a new school of big-game hunters, whose trophies are destined not to lurk and moulder in the darker parts of museums or the smoking-rooms of clubs, but to come to life again and again on an illuminated screen and to give to thousands of people a thrill that the stuffed beast can never give. These intrepid people

pursue their quarry armed with a battery of cameras and films in place of high-velocity rifles and death-dealing bullets. There is no intention here to disparage the big-game hunter with the gun—many of them are, or were, among the finest explorers—but not all of them were naturalists, and the man with the camera must needs be naturalist as well as photographer. One of the pioneers of this new school is Major Radclyffe Dugmore, whose latest book ' The Wonderland of Big Game ' is the graphic record of the most recent of his journeys to East Africa in search of big-game pictures. It is not always a record of success—it would not be true if it were—but it is written in a tone of admirable modesty, and it is illustrated with photographs which are worthy of the highest praise. As a naturalist Major Dugmore is greatly concerned with game preservation, and he has some interesting things to say about the results of the present regulations. One of the most remarkable is the increase of giraffes, which are now becoming quite numerous and much less shy than formerly. It is, very rightly, considered unsportsmanlike to shoot a giraffe, so it may be hoped that the spectacle, which the writer of this notice had the misfortune to see, of seven giraffe carcases (the tails cut off) rotting in the sun, may never again be possible. The Buffalo have also increased in numbers after having been nearly exterminated by rinderpest, and are in some districts a good deal too common for the liking of the settlers. Lions have diminished in the more settled regions, but they hold their own in the wilderness. Major Dugmore thinks that their habit of ascending to high altitudes in forest regions may be a new one, due to persecution in the plains. This is not necessarily the case ; lions go far up the mountain forests in search of the succulent pigs, which are most destructive visitors to native cultivations. The future of the elephant is uncertain. It is estimated—but this may be greatly exaggerated—that there are half a million in Kenya and Tanganyika, and there must be fully as many in Uganda and the Congo, not to mention the Portuguese territories east and west. Inevitably the number of elephants cannot but diminish *pari passu* with the opening up of the country. One may only hope that an international agreement will be made in good time for the establishment of reserves, where these most remarkable animals may live through future ages. The book closes with a useful chapter on equipment and the methods of photographing wild animals.

The battery of the author of ' A Naturalist in East Africa ' consisted of a butterfly net, pill boxes, and a pair of very observant eyes. Dr. Hale Carpenter was a medical officer in various parts of Uganda, Tanganyika, and Portuguese East Africa during the war. The campaigns in those regions were spasmodic and liable to long interruption, which wearied the military people but provided endless opportunities for the patient naturalist. Most of Dr. Carpenter's observations are concerned with mimicry and the colours of animals, on the lines of the work of Professor E. B. Poulton, to whom the book is dedicated. There are a number of photographs and diagrams. A. F. R. W.

AMERICA

The Wonderland of the Old South-West. Charles F. Lummis. London : George Allen & Unwin, Ltd. [1925.] 8½ × 5½, pp. xvi. + 517. *Illustrations.* 18*s. net.*

Mr. Lummis has striven for years to induce Americans to " see America first," and more particularly the area in Arizona and New Mexico described in this book. Here, besides striking natural scenery, he can point to the sites of oldest continuous occupation in the continent, the homes of the " First

Americans," as he calls the pueblo dwellers. He is a good showman, knows a great deal about his subject, and can write attractively. Settlements such as Acoma, Indian culture and legends, with the intermixture of Spanish and modern American influences, provide plenty of interesting material. The tale of the vindication of the Indian legend of the "enchanted mesa" is an instance of his success in establishing Indian history and culture as worthy of careful study. In pressing home this point he sometimes allows his enthusiasm and his indignation against the casual or indifferent traveller to run away with him, and to be diverted against the white man, more particularly the American, and his works in general. In the Indians he sees "all our virtues and only part of our vices." It is surely almost unnecessary to add that the travellers in Europe to whom Mr. Lummis rightly objects are likely to derive just as little benefit from their own "South-West." The point at issue is the relative value of the two fields of study to men after Mr. Lummis' own heart.

The Relation of Nature to Man in Aboriginal America.— Clark Wissler. New York: Oxford University Press (American Branch). London: Humphrey Milford. 1926. $8\frac{1}{2} \times 5\frac{1}{2}$, pp. 248. *Maps.* 18*s.* 6*d.*

Professor Wissler's new volume (a reproduction of a series of lectures) is more than a summing-up of his previously published monographs of the various aspects of the social anthropology of the "Indian" tribes of that part of North America to-day comprising the United States: as a survey of certain cultural and physical peculiarities of these tribes, demonstrated by charts and maps showing zones of distribution, it must prove of definite use to the student.

The book does not, by any means, justify its ambitious title, since its range is limited, except for casual reference to one or two broader points, to the United States; and even within this range Professor Wissler has chosen only a small number of racial characteristics, dealing with them at times but lightly, as in the superficial section on the highly important question of linguistics. Had the subject of aboriginal man in the New World really been surveyed, we should, no doubt, have had more of such valuable charts as that on p. 206, showing agricultural zones of the Americas and the relation of maize cultivation to the development of the city-state; and the author would then have taken into account not only the mounds of the U.S.A., but the far more eloquent and astonishing megalithic remains of Central and South America.

Mr. Wissler presents his material agreeably, with an honesty and open-mindedness not invariably the trait of the anthropologist; he is not so much concerned with making a case as with correlating scattered information and trying to arrange it ready for deductions; and for this purpose his work is admirably adapted. Along this path more light upon the vexed question of man in the Americas is greatly needed.

The volume is well printed and presented, and one probably need not blame the proof-reader for "floræ and faunæ" any more than for "percentile" and "objectifications" and "methodological." However, Mr. Wissler may enjoy inventing words. L. E. E.

AUSTRALASIA AND PACIFIC ISLANDS

The Adventure Book.— Elinor Mordaunt. London: John Lane. 1926. $9 \times 5\frac{1}{4}$, pp. xiv. + 272. *Illustrations.* 15*s. net.*

This is the record of much determination displayed, and often considerable hardship borne, by a novelist in the Pacific islands. Mrs. Mordaunt made up her mind to go from Marseille to Tahiti on a French cargo boat, and did so.

She then determined to reach Samoa and Fiji by a somewhat mysterious schooner under the Panama flag: again she was successful in spite of much opposition, finally having to sign on as a nominal stewardess. These are but two examples of her success in avoiding conventional paths. The greater part of the time she confesses to acute discomfort, and at least on one occasion she found herself in a position of danger. Thus she achieved her ambition "to live wonderfully, to live dangerously." The continual analysis of her own motives gives the book a somewhat self-conscious air, and there is sometimes a straining to place facts in as unusual a light as possible. The brief sketch of Marseille at the start appears forced, but the passage through the Panama Canal is certainly described with freshness. In the Pacific the search for novelty is relatively less severe, and the account of islands visited, including the Fiji and Tonga groups, and people met, runs smoothly. The author, however, is always haunted by the thought that "There is something better, other places, other people." From the appendix one gathers that in her wanderings she reaches the north-east coast of Africa, though the book concludes off Sydney. The photographs are not of great merit.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

A Study of the Oceans.— James Johnstone, D.Sc. London: Edward Arnold. 1926. 9 × 6, pp. viii. + 216. *Sketch-maps and Diagrams.* 10*s.* 6*d. net.*

The pronounced impression produced by this book upon at least one moderately patient reader is that exceedingly little can be said in its favour. It professes to trace the probable evolution of the Earth's main features, the growth of geographical knowledge, and the effect upon geographical conceptions of the results of modern oceanographical investigation; but the information which it contains is marred by the presence of so many astonishing blunders, with regard to matters of scientific and historical fact, as to render it merely amusing to readers who possess even a superficial knowledge of these subjects, and actively harmful (because misleading) to the neophyte.

For example, he is informed (p. 52) that "the difference, in hours, between local time and Greenwich time, *divided by* 15, gives us the difference of longitude in degrees . . .," and also learns (p. 78) that the Earth possesses four magnetic poles, "*two* of them in the north and two in the south" (the italics are, in both cases, Professor Johnstone's). Confronted with this sudden resurrection of a magnetic theory generally abandoned for almost a century, it is with no shock of surprise that one finds on the following page that the variation, in the example showing how to convert compass to true bearings, has been applied the wrong way.

In compiling his historical information, the author has fared no better. He tells us that Vasco da Gama circumnavigated Africa (p. 69); that Columbus, on his first trans-Atlantic voyage, sailed from Portugal (p. 84); and that the famous Franklin record found by McClintock's expedition was signed by "the captain and first officer of the *Erebus*" (p. 111). Even in matters of contemporary history his ill-fortune pursues him, for he makes Scott sail on his last expedition in the *Discovery* (p. 123) instead of the *Terra Nova*. The very names of explorers suffer strange sea-changes: thus we have "Behring" (*passim*), "Weybrecht" (p. 115), and "Raold Amundsen" (pp. 113, 122); while as if to ensure, as far as possible, the permanent association of a misleading date with a totally incorrect statement, the reader is twice informed (pp. 55. 141) that John Harrison invented the modern chronometer in 1749.

As regards matter more purely geographical, it is surprising to learn (p. 121) that the Antarctic Continent, in spite of its circumpolar situation, possesses a north-east and a south-east part. The statement (p. 146) that the continental shelf extends to the 1000-fathom line is also somewhat at variance with accepted ideas.

The maps and diagrams accompanying (and occasionally defying) the text are more remarkable for quantity than quality, having apparently been drawn *currente calamo*, and lettered to match. The largest map, that of the Arctic regions (Fig. 17), specifically referred to (p. 107) as a "modern chart," somewhat singularly omits to show Emperor Nicholas Land or any of Stefansson's discoveries. On the other hand it is gratifying, in the interests of accuracy, to notice that the statement (p. 121) that Alexander I. Land is "actually part of the Antarctic Continent" has been duly contradicted in the diagram on p. 127, where this land is correctly shown as an island.

There is a tolerably good index. R. T. G.

HUMAN AND HISTORICAL GEOGRAPHY

Prehistoric Man and the Cambridge Gravels.— F. Smith. Cambridge: W. Heffer & Sons. 1926. 8½ × 5½, pp. viii. + 122. *Illustrations.* 7*s.* 6*d. net.*

This little book, devoted to a description of roughly worked flints, their use and hafting, is rather a labouring of the obvious, for doubtless most of them are human artifacts, and capable of being used in the ways suggested. But the author's contention that some of his finds show clear evidence of human sculpture is another story. Nevertheless, he raises again a very interesting question which has not received the unprejudiced attention it deserves. Boucher de Perthes long ago contended for the human workmanship of certain stones among his discoveries that simulated animal forms, and more recently Mr. Newton has described and discussed similar "figure stones." But neither found much attention or favour for their views. There is however nothing unnatural or surprising in these views; rather the reverse. The palæolithic man whose existence depended on hunting the wild animals around him must have had his attention constantly directed to their character and appearance. His observational faculties in this direction must have been keenly stimulated. This being so, what more natural than for him, on finding a stone which chanced slightly to simulate some animal form, say the head of a bird or quadruped, to emphasize the similarity by touching it up by flaking or chipping? Further, the existence of such rough sculptures seems to be practically a necessity, when the carving and sculpture of the Aurignacian age is considered: the Aurignacian figurines were not a beginning, but must have been preceded by many earlier efforts in Acheulian or even Chellian times.

Although few will feel such admiration for his rough flint sculptures as does the author, yet that flint was so worked in ancient times is shown by Petrie's discovery at Abydos, and figured by Capart, of a baboon chipped in flint. Mr. Smith may therefore take heart, for there is precedent, or at least analogy, for his flint baboon's head!

The book is illustrated with twenty-eight plates containing nearly two hundred drawings by the author. The enthusiasm he evinces for Prehistory after sixty years of collecting and study is certainly a tribute to the interest of prehistoric archæology. E. A. P.

Industry and Commerce.— **J. Russell Smith.** London: Constable & Co., Ltd. (New edition.) 1926. 8 × 5½, pp. vii. + 769. *Numerous Maps and Illustrations.* 12*s. net.*

This new edition of Professor Russell Smith's text-book (in which the title has been changed from 'Commerce and Industry' to 'Industry and Commerce,' so as to avoid confusion with another publication), exemplifies again the author's skill in organizing the great mass of material with which such a book is concerned. The volume includes, of course, much of the contents of his 'Industrial and Commercial Geography,' but this is here arranged more regionally, so that all the matter concerned with the United States is drawn together into the first and largest part of the book: within the section, however, the regional treatment is frequently discarded. Among the foreign countries dealt with in Part II., special attention is given to Latin America and the Orient as being of exceptional interest to the United States. Part III., representing the commercial section of the Industrial and Commercial Geography, has a final chapter on "World Trade during and after the War," in which Professor Russell Smith traces the significance of the "remarkable disturbance of trade" that was then occasioned, and deals with the profound changes in the basis of American commerce in the post-war period.

There are the numerous and distinctive illustrations that one has become accustomed to expect in these books, including new diagrams and revisions of those previously included (though apparently these are not indexed), and the tables of statistics in the appendix are brought up to 1923 or 1924. B. H.

Tea: An Historical Sketch.— **Robert O. Mennell.** London: Effingham Wilson. 1926. 10 × 7, pp. 63. *Portrait and Illustrations.* 6*s. net.*

Although mainly concerned in tracing the fortunes of a tea firm founded in 1725, this little book contains a certain amount of material which may properly be called "geographic" or "economic." Such is to be found, however, in incidental references scattered through the book, rather than in chapter ii., which purports to treat of "The Geography of Tea," but does this very shortly. Thus of special interest are the facsimiles of early tea catalogues and price lists, like that of the East India Tea Company, 1785, which shows the "descriptions" and "putting up" prices of the goods manufactured over a century ago, and the detailed price list reproduced on p. 44. In the plan of the author the book sketches in outline "something of the romantic, the commercial, the social, and the political history of tea," and in view of the annals at his command, and the value of seeing the practical effect, as illustrated in the history of a pioneer firm, of the complications—legislative and otherwise—which attended eighteenth-century trading in tea, one could wish the record had been written at greater length. B. H.

The Clove of Commerce, including Cost and Charges Calculator.— **W. Grazebrook.** London: The Commercial Calculating Co., Ltd. 1925. 9½ × 6, pp. 81. *Illustration.*

This volume consists almost entirely of a series of calculator tables, statistics, and trade regulations for the use of the commercial communities of Zanzibar and Pemba interested in the clove trade. But though provided for the merchant and trader and not for the geographer, the tables with their accompanying notes may be interpreted so as to give a most interesting account of the chief economic development in the islands. For Zanzibar (though the author does not treat of this), having with the development of the

neighbouring mainland and its ports lost its original importance as a port of transhipment and distributing centre, concentrated more and more on the clove trade, until now it, with Pemba, is responsible for no less than 92 per cent. of the world's supply, and the clove crop represents the chief interest of the population as well as, through the duty in kind levied on the product, the chief source of revenue for the Government. Indeed, the dependence of the islands on this one crop has a more than usually serious aspect when one remembers the experiments being carried out in England and in the United States for the improvement of the methods of manufacture of a synthetic vanillin. Such experiments are almost certain to result finally in a cheaper method of vanillin production than from high-priced cloves, and may bring disaster to Zanzibar and Pemba. For the present, however, the statistics of export quantities and prices given by the author show the importance of the trade.

B. H.

The Cambridge Ancient History.— Vol. 4. The Persian Empire and the West. Cambridge University Press. 1926. $9\frac{1}{2} \times 6\frac{1}{2}$, pp. xxiv. + 698. *Maps and Plans.* 35*s. net.*

In this volume the History of the Persian Empire is brought down to the end of the reign of Darius by the late Dr. G. B. Gray. The political vicissitudes of Athens from the time of Draco to the Peisistratids are related by Prof. Adcock, and Athenian history is then continued by Mr. Walker down to 491 B.C. We are thus enabled to picture the condition of Athens at the time of the Persian invasion. The outstanding features of the volume are the critical account of that invasion by Mr. J. A. R. Munro, and the effort, chiefly from a linguistic standpoint, of Prof. R. S. Conway to solve the Etruscan riddle. Whilst the former may be said to have settled several uncertain and difficult questions by its criticisms and re-interpretation of the evidence, the latter, notwithstanding its scope and learning, leaves us still very much in the dark regarding the Etruscans and their language. Prof. Conway's remarks on the early inhabitants of Italy will be read with interest, if not with entire conviction, by historian and ethnologist alike. Etruscan art, which gives us the most striking evidence of their culture, is discussed in an interesting section by Mr. Casson. Prof. Ure gives a sketch of the Outer Greek World in the sixth century, and we follow the Greek penetration into the Black Sea, Egypt, Cyrene, and the Western Mediterranean. In their expansion westward the Greeks came into conflict with the Phœnicians, who on the rise of Carthage became there the predominant power. This subject is dealt with by Mr. Hackforth, who describes events in Sicily, especially the rise of Syracuse, and the prolonged struggle which culminated in the signal defeat of the Carthaginians at the battle of Himera in 480 B.C. The development of commerce following this spread of Greek influence stimulated the production and use of coined money, and very suitably Dr. Hill of the British Museum contributes a short, but most instructive, chapter on Coinage from its origin to the Persian wars.

The student of Ancient History will read with pleasure and profit the essay on Greek Literature from the eighth century to the Persian Wars by Prof. Bury, and that on Mystery Religions, and pre-Socratic philosophy by Mr. Cornford. The latter is a remarkably sympathetic study of the ancient philosophers and their views of life. The volume concludes with a chapter on Early Greek Art down to 500 B.C. by Prof. Beazley, and a short description of Greek Architecture contributed by Mr. D. S. Robertson.

Early publication of a volume of plates supplementary to vols. 1 to 4 is

promised, and, in making good the absence of much-needed illustration of the sections therein devoted to Art, will be heartily welcomed by all who have read them. E. A. P.

GENERAL

The Empire Cruise.— **V. C. Scott O'Connor.** London: Riddle, Smith & Duffus (privately printed). [1925.] 8½ × 5½, pp. 301. *Illustrations.* 15*s.*

As the Ettrick Shepherd once remarked of sheep's head, there is "a lot of fine confused feeding" to be found in this book, which is a description, by a non-naval participant, of the voyage round the world performed in 1923–1924 by the Special Service Squadron (H.M.Ships *Hood*, *Repulse*, *Delhi*, *Dauntless*, *Danæ*, and *Dragon*) under Vice-Admiral Sir Frederick Field.

Obviously the work of a trained observer with enthusiastically Imperial views and great general knowledge, it should make a wide appeal as a detailed and permanent record of a prolonged "hurrah party" admitted on all hands to have been an extremely successful and popular one. It is not, however, very easy reading. With quite unnecessary modesty, Mr. Scott O'Connor has chosen, while writing the central portion of his book in the first person, to begin and end it in the third, employing the latter even when detailing his purely personal adventures when away from the Squadron, thus frequently affording (*e.g.* in the description of his journey to Kilimanjaro, pp. 71–78) that most moving of all spectacles (according to Aristotle)—the sight of a good man struggling against (grammatical) adversity. The effect, on first reading, is almost as singular as that produced by Sully's 'Memoirs' (which, for no ascertainable reason, were written throughout in the second person). It is scarcely necessary to say that the middle third of the book, in which the veil of impersonality is temporarily discarded, forms a welcome oasis.

The author's excursions into the higher realms of descriptive prose are not always successful. Such passages as:

> ". . . the Atlantic, rejoicing in his might, played about us; the white crests of his foam broke in prisms upon his dark ultramarine, . . ."

and

> ". . . The ships maintained their even distance by day and by night, images of discipline, order, and restraint; their latent passion and fierce initiative subdued to the Admiral's will,"

probably look funnier, thus isolated from their context, than they really are, but it can hardly be denied that they read perilously like parodies upon a certain class of nautical fiction.

Mr. Scott O'Connor's general culture and wide reading, historical and otherwise, are generously displayed upon almost every page, yet one rarely catches him tripping. In writing of Krakatau, however (p. 119), he forgets, as most people do, that the so-called "Krakatau sunsets" were seen in Natal several months *before* the eruption; while the accepted meaning of "Creole" is not a person of slave descent (p. 31), but one of pure white ancestry born in the West Indies. And surely the Mackenzie, even with the Athabaska added, is not 4000 miles in length (p. 253).

The illustrations, some in colour and the remainder from photographs, are good and clear. The frontispiece, a view of Kicking Horse Canyon, bears the somewhat misleading title "Kicking Horse Cavern."

The book, to which the Rt. Hon. L. S. Amery, Secretary of State for Dominion Affairs, contributes a benevolent Introduction, concludes with a somewhat unusual feature—a nominal list of every man, from Admiral to canteen steward, who served in the Squadron during the cruise—5051 names

in all. It would have been considerably improved by the addition of a map and an index. R. T. G.

THE MONTHLY RECORD

EUROPE

Maps of Ireland to A.D. 1700.

WE have received from Mr. M. C. Andrews of Belfast the reprint of a paper contributed by him to the *Proceedings* of the Belfast Natural History and Philosophical Society (Session 1923–1924) on " The Map of Ireland A.D. 1300–1700." It is the first attempt yet made to discuss the whole early cartography of Ireland systematically, and by his study of the subject during many years Mr. Andrews was particularly well qualified for the task. He divides the whole period into five subdivisions, viz. Ancient, Mediæval, Period of Marine Charts, the Sixteenth Century, and the period from the Reformation of Cartography to Petty. Maps of the first two periods (represented respectively by Ptolemy's rough sketch in which but few of the names can be identified, and the mediæval *Mappæ Mundi*, like that of Hereford) are naturally excessively crude, and need not be dwelt upon here. With the Portolan Charts, of which Mr. Andrews has studied something like 250 specimens, we first find traces of fairly detailed knowledge. As the charts were almost exclusively Italian or Catalan, the knowledge displayed especially of the west, south, and east coasts might seem surprising, but is explained by the considerable and often direct trade with Ireland maintained by Italian cities in those early days. Mr. Andrews finds that the great majority of these charts produced during 300 years fall within six main types, the characteristics of which he defines. The first held its ground with little change for about a century and a half, and the conservatism of the chart-makers is shown by the fact that no chart of this type marks Galway, which, though only a fishing village in 1170, was walled in 1178 and began to grow and prosper in the early fourteenth century. The early sixteenth century saw a considerable accession of knowledge, as shown both by the improved outlines and new names added in charts of the third type, but there was some retrogression in the time that followed.

Apart from the maps given in the various editions of Ptolemy, the earliest printed representations of Ireland are to be found in the series of maps of the British Isles (with one of Ireland by itself) produced in Italy in the sixteenth century, all based on George Lily's of 1546. Next comes the Ireland of Mercator's big map of Europe of 1554, a close copy of which (for Ireland only) was given by Porcacchi in ' L'Isole piu famose ' of 1572. But he gave it an entirely false orientation through failing to take account of the curve of the meridians in Mercator's original. Several MS. maps of this period still exist. One, supposed to be of the time of Henry VIII., is interesting as showing the three main roads (north, west, and south) leading out of Dublin. Another, dated 1567, by John Goghe, is preserved, we believe, at the Record Office, though this is not stated. Two by Dean Nowell, of about 1570 or 1572, are in the British Museum, while one, by Baptista Boazio (an Italian employed by the Government), probably of about 1575–76, is at Trinity College, Dublin. We have also several county and provincial maps by John Browne and Francis Jobson. Of the maps following the Reformation of Cartography, Mr. Andrews defines seven types, including that resulting from Petty's Survey. Mercator's version in his ' British Isles ' of 1564 was closely copied by Ortelius, while

in the Mercator Atlas of 1595 considerable changes are introduced, some apparently based on an intermediate type due to Boazio, a unique printed example of whose map is in Trinity College, Dublin. It is of interest to learn that a copy engraved by Peter Kaerius and published by Hondius in 1591 exists in the Linen Hall Library at Belfast, for this would seem to be an undescribed work of the two Dutch map-makers. Speed's map, engraved by Hondius, is another type, and may have been based on the survey completed by Robert Lythe in 1572. Examples of the remaining types are supplied by Sanson's map of 1640 and the Marine Chart of Peter Goos of 1666, the latter showing a good deal of improvement on its predecessors. Petty's well-known survey was the starting-point of the modern mapping of Ireland.

Flemish Towns.

A study by Dr. Friedrich Leyden entitled "Die Städte des flämischen Landes" has appeared as Part 2, vol. **23**, of the *Forschungen zur Deutschen Landes- und Volkskunde*. The paper falls into two parts: the first is general, and deals with the Flemish towns under various headings, such as situation, plan, size, etc. In the second, five towns—Brussels, Louvain, Malines, Antwerp, and Bruges—receive more detailed treatment.

The section of Part I. which deals with situation is of particular interest, and the relation between routes and towns is brought out very clearly, although one regrets the absence of maps in this, as indeed in most sections of the book. The plan of the town—a subject on which German geographers have done such valuable work from the middle of last century—is somewhat more condensed and less detailed than in other works in this series, as, for example, in Dr. Geisler's "Die deutsche Stadt"; while in the section on elevation (*Aufriss*) the want of photographs or drawings is much felt. The only illustration is a photograph of "der Beginenhof" in Turnhout, one certainly full of interest.

The detailed treatment of the towns in the second part of the book gives a most vivid picture of these as growing and changing entities, and is the kind of thing one would like to have in one's hand while visiting the towns described. The historic interest of these towns has to some obscured the geographic, and we are grateful to Dr. Leyden for the way in which he has emphasized the latter interest. Here again one would have welcomed plans of the towns, but possibly these may be included in a later edition of the work. G. M.

ASIA

Geomorphology of S.W. Central Asia.

From a study of the literature of the subject and his own observations in Afghanistan and the North-West Frontier, Dr. Trinkler has contributed some suggestions on the geological and morphological evolution of South-West Central Asia to *Petermann's Mitteilungen*, Heft 3–4, 1926. (A general note on his work in Afghanistan was given in the *Journal* for August 1925.) Of the three ranges forming the Parapomisus, the Kuh-i-Baba and Bend-i-Baba are of Palæozoic age, while the Hindu Kush is Miocene. In the two former portions, the Palæozoic strata are much contorted and the Red Grit beds rest unconformably upon them, with a dip of 5° to 25°. Most of Northern Afghanistan is covered by Cretaceous strata. Such formations are found across the Hindu Kush, and appear to merge with the great Tibetan deposits. The extent of the Trias beds shows that the area of the Indo-Afghan Trias sea was limited by mountains on the west and north. The geological strike throughout this region lies approximately between N.E.–S.W. and E.–W., the direction

of the great fault line. On the east the beds were bounded by Gondwana-land. The pressure of the young mountains on the old produced much distortion. As it progressed, the sea gradually withdrew, this phase being completed by early Tertiary times. The early Tertiary deposits are represented by grey sandstones, similar to the Indian Siwalik beds, and conglomerates. The younger, level beds rest unconformably upon the older. The Siwalik beds are found chiefly to the south of the fracture line; they are now associated, as in Baluchistan, with an arid climate, but the precipitation in this area must formerly have been heavy. The beds are now at considerable heights (over 3000 metres), having been arched up at the end of the Pliocene, and are in some places as much as 4000 metres thick. A large system of rivers and much precipitation must have been required to lay them down in the deep troughs they occupy. The Brahmaputra flowing in the opposite direction may have assisted in this work. From a study of the Eocene deposits of India and Tibet it appears that the two seas may have been united through a gap in the south-western Himalaya. Through this gap also the Tertiary sea withdrew from Central Asia. Dr. Trinkler's conclusions therefore are that South-Western Tibet once formed a great interior basin, into which rivers transported eroded material from the North Himalaya and Tibet; that this area was one of considerable precipitation; that the south-west portion of the Himalaya is younger, and reached its present height later, than the eastern range; and that through this gap the monsoon penetrated to the interior. As the summits alone display evidences of glaciation, he supposes that this gap was only recently closed, through epirogenetic movements which have not yet entirely ceased. The result has been the damming of rivers to form lakes, and the development of an arid type of climate.

AFRICA

The Gold Coast Survey Department.

The recent development of the Survey Department of the Gold Coast, as detailed in the Reports for 1923–24 and 1924–25, which we have received from the Surveyor-General, Lieut.-Col. R. H. Rowe, D.S.O., displays several points of interest. The earlier report devotes considerable attention to the training of Africans for survey and reproduction work. In 1920 a survey school was opened at Odumase with forty pupils. Some of these have progressed very favourably, so that, for instance, the entire work on a sheet of the 1/1250 Cadastral Survey of Accra has been done by African surveyors. Similar advances have also been made in the reproduction and printing of maps locally by zincography from the drawings of African draughtsmen. It has been decided to print the ½-inch standard sheets at Accra; the Bompata Sheet has already been issued, with a considerable saving of time and outlay, amounting approximately to £70 for that sheet. The Report for 1924–25 contains details on the use of wireless time signals in the field, equipment used, and results obtained. Through the comparatively slow progress of the rigid framework of triangulation, the topographical work is being based upon observed latitudes and wireless longitudes. Accordingly wireless experiments were begun in 1924. After some delay through local conditions and defects in the equipment, satisfactory results were obtained: the conclusion arrived at being that "whenever and wherever it is possible to observe stars, it is possible to receive time signals satisfactorily." The signals from Bordeaux were found to be the strongest, and were most used. In the scheme evolved, it is calculated that the cost of this wireless party will be about £2600 per season, during which time

from thirty to forty points should be fixed. This will decrease in time, and is already cheaper than cutting traverses, etc., in thick bush.

Experiments made at Accra to compare its longitude obtained by wireless observations and by telegraphic signals from Cape Town by Major Guggisberg twenty years ago, showed a difference of 1·40″, but this figure is subject to further correction. During 1924–5, 5200 square miles were surveyed topographically, bringing the total to 41,000 square miles, or almost half the area of the Gold Coast The triangulation framework has also been carried on as well as boundary surveys, and cadastral work. A tide gauge has been obtained, which is to be installed at Takoradi when the harbour works are sufficiently advanced. The Reports contain examples of cadastral and topographical maps on various scales, including Accra and Kumasi on 1/1250, and the Bompata sheet of the 1/125,000 survey.

AMERICA

The Bottom Deposits of Lake Ontario.

In an important paper printed in the *Transactions* of the Royal Society of Canada (Third Series, vol. 19, 1925, Section IV., pp. 47–102) Mr. E. M. Kindle gives the results of the first serious attempt at a survey of the Bottom Deposits of any of the Great American Lakes. The field-work for the investigation was begun by the writer under the auspices of the Geological Survey of Canada in 1914, and he afterwards devoted parts of two other seasons to it. The late Mr. E. J. Whitaker spent the entire season of 1915 and part of that of 1916 on lake work, and got together most of the data embodied in the maps accompanying the present paper. Apart from minor investigations by Prof. S. I. Smith on Lake Superior (in connection with biological work) and a series of dredgings made by Prof. H. A. Nicholson in Lake Ontario in 1872 within a radius of 10 miles from Toronto, nothing of importance had been done in this direction, and the information recorded on the charts of the Lake Surveys is of the most meagre character. In the recent investigation a series of bottom surveys was made of selected areas, which it was thought would give a clear idea of the bottom conditions prevailing generally. They were carried out by gasoline boat traverses run on parallel courses, usually about at right angles to the shore. After a description of the apparatus used, Mr. Kindle gives a useful summary of the general features of the lake and its basin, with notes on the water temperatures, the materials of the lake-shores, wave and current action, and so on. The materials of the coast-line fall into the two general classes of consolidated and unconsolidated beds, representing Palæozoic and Pleistocene deposits. The latter, found chiefly between the western end of the lake and Toronto, consist mainly of lake clays and till, with some interbedded sands, and the rapid retreat of the clay cliffs has furnished vast quantities of material for lacustrine sediments. The distribution and sorting of the eroded material is effected both by wave action and by currents, the latter, through the sand held in suspension, exercising a scouring effect to much greater depths than the former. The bays tend to be filled by bio-chemical processes—formation of marl by plant action, etc., the deposits being also intermixed with blown sand. The detailed surveys were carried out (1) in the V-shaped bay at the western end ; (2) off Toronto and to the east of it ; (3) in Wellington bay and adjacent areas. In addition two complete cross-lake traverses were made, two near the western end, the third between Wellington and Oswego. The resulting charts bring out clearly the general distribution of the deposits and the effect thereon of depth and distance from shore. The

whole of the mid-lake region is occupied by fine muds, while nearer the shore the deposits vary considerably and a wide extent of bed-rock is also met with. In the Toronto area all the traverses reached the mud line at distances ranging from 4½ to 8 miles. Zones of plant and animal life are also in accordance with variations of depth, and the deep fauna is entirely distinct from that of the shallower parts. The failure of light penetration is probably an important factor in discouraging the migration of mollusca to the greater depths, as it is undoubtedly the chief factor in limiting the downward extension of plant-life.

The Canadian Arctic.

The work of the Canadian Government in establishing a chain of police posts in the islands of the Canadian Arctic has previously been described in the *Journal*. In 1922 a party failed to reach Fram fiord in Ellesmere Island, but established a post under Inspector Wilcox near by, at Craig harbour (*Geogr. Journ.*, **63**, 457). The following year the Inspector set up another post at Pangnirtung fiord on the east coast of Baffin Island (*Geogr. Journ.*, **64**, 350). Since then several attempts have been made to establish one farther north. It is reported that this year the annual relief expedition, under Mr. G. F. Mackenzie, has returned, having succeeded in placing on Bache peninsula, Ellesmere Island, in latitude 79° 4′ N., the most northerly police post in the world. This display of activity is further evidence of the determination of the Government effectively to occupy these Arctic islands.

A further piece of exploration in the North-West Territories lately reported is the discovery of the headwaters of the Thelon river by Mr. G. H. Blanchet, of the Topographical Survey Branch. The source of the river, which flows into Chesterfield Inlet, Hudson Bay, had previously been shown, on the strength of Indian reports, as issuing definitely from a chain of lakes north of Lake Athabaska. The results of Mr. Blanchet's journey over a little-known area show that the Thelon is rather the drainage system of a great number of lakes than that of a small well-marked chain, but further details of his work have yet to be received.

AUSTRALASIA AND PACIFIC ISLANDS

The Population of New Zealand.

The General Report volume of the " Results of a Census of the Dominion of New Zealand taken . . . 17th April 1921 " (Wellington, 1925), gives interesting details on the general movement of the population in the Dominion. The total for New Zealand proper is returned at 1,218,913, and the Maoris at 52,751. This represents an increase in the white population of 210,445 since 1911, or roughly 20 per cent. Calculated on the basis of area fit for settlement, this gives a total density of 15 per sq. mile. The tendency has been for the North Island to increase more rapidly than the South, the increments between 1916 and 1921 being 13·6 per cent. and 6·5 per cent. respectively. The " centre of population " has, in fact, moved steadily north-eastwards since 1881. The chief source of the growth of New Zealand's population has been the natural increase of the people : between 1911 and 1921 this was 165,612, while the excess of arrivals over departures was 50,415. The result was that 74 per cent. of the population was native born, while 24 per cent. was born in other parts of the British Empire. The effects of settlement by nationalities are still to be observed in certain districts and are reflected in some place-names. Scots have settled in Otago, for example, Swiss in Taranaki,

and Yugo-Slavs in Auckland. Roughly half the inhabitants are found in the fifteen urban districts into which the two islands are divided.

The most thickly settled Provincial District was that of Wellington, which includes three urban areas, the next being Taranaki, followed by Auckland, Hawke's Bay, and Canterbury. The chief feature of the period 1916–21 is stated to be the growth of the Auckland Provincial District, its increase equalling 51 per cent. of that of the Dominion. The maps of the distribution of population by smaller areas (census subdivisions of counties) show that settlement in the South Island, except for areas around Nelson and Hokitika, is largely confined to the eastern and south-eastern coastal plains. In the North Island, though distributed fairly evenly around the coasts, it is denser on the western side. Other maps show the increase or decrease of population by groups of counties. That for the North Island shows a striking increase in the Waikato and Bay of Plenty districts of approximately 34 per cent., and decrease in the urban population of the Thames locality, and the area south of Hawke's Bay. In the South Island, decreases of 6·6 and 2·4 per cent. respectively are shown in the Buller-Grey and Otago Central Districts. The greatest increase (12 per cent.) is in the Christchurch area.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

The Doldrums of the Atlantic.

The equatorial doldrum belt, like the Trade winds which bound it, have long become stereotyped conceptions in the text-books, and one therefore values a discussion by Mr. C. S. Durst on its real character (*M. O. Geophysical Memoirs*, No. 28, 1926). The memoir is naturally full of technical matter of more particular interest to the meteorologist, but from the geographical point of view two points emerge which deserve emphasis. The first is that, apart from the seasonal swing of the doldrums north and south of the equator, the width and shape of the belt is very variable from day to day. For days at a time the belt is wide, perhaps as much as 600 miles in extreme cases, then there comes a sudden burst of the Trade winds invading the area of calms and reducing it to practically nil. Mr. Durst has arrived at this conclusion from the study of a vast amount of observational material available for the Atlantic Ocean in the Marine Department of the Meteorological Office, and confirms the description long ago given by Maury. It is certainly satisfactory to have a direct observational verification of an obvious principle. "Doldrums," "Trades," "Westerlies," and the like are statistical generalizations whose momentary phases indicate a perpetual state of oscillation about a mean condition; however important to bear in mind as a background for reference, such generalizations but rarely represent the actual circulation.

The second point is that the Doldrum rains, which mainly take the form of thunder squalls, are a much narrower belt than the corresponding equatorial rains on land, notably those of the Congo and Amazon valleys. The reason for this is clearly explained by Mr. Durst. Above the equatorial lands extensive heating over a wide area furnishes the impetus for extensive convectional rains in the belt between the Trade winds. Over the ocean, on the contrary, where the heating is more uniform and less marked, convection is not so easily started, and would in most cases appear to originate dynamically, rather than thermally —in the more immediate impact of the opposing trades, one of which is damper and lighter than the other.

Differences of humidity are considered, in fact, to play a large part over the equatorial oceans. Thus day-to-day fluctuations in the position of the

doldrums are associated with variations in the water-content of the Trade winds, whilst the seasonal variation of the same is more intimately connected with the position of maximum humidity than of maximum temperature.

Plant Distribution in the Pacific.

A comparison of the plant-life of Juan Fernandez and Hawaii, and deductions therefrom regarding the past physical history of the Pacific with special reference to plant dispersion, are made by Prof. Carl Skottsberg in *Bulletin* 16 of the Bernice P. Bishop Museum (Honolulu, 1925), on the basis of personal investigations in 1916–17 and 1922. Summarizing the floral elements in the two groups he finds (1) that there is in both a strong Pacific element, not directly represented on the neighbouring continents, but to some extent in New Zealand and Polynesia. Many of these plants are woody, and many belonging to very different families show the peculiar life-form of "rosette-trees." All are endemic, and include most of the systematically isolated genera and species. He considers that these dwarf trees cannot be interpreted as a late adaptation to an insular, windy climate, as Schimper thought, but that they probably represent a type better represented during the Tertiary. (2) Hawaii has a large Indo-Malayan element lacking in Juan Fernandez. (3) Both have Australian–Polynesian types, not occurring in America, although Juan Fernandez is only 360 miles from Chile. (4) Both have American types; and (5) Both have subantarctic species, forming two extreme outposts of the circumpolar flora (the Hawaiian species are fewer, but it is surprising that there are any at all). No direct or striking systematic relations can be established between the two floras, but many features indicate a similar history, and in view of the general similarity in their geology, climate, etc., it is reasonable to regard them of the same class—either both oceanic, or both continental. After a general discussion of the origin of island floras (in which he holds that Transoceanic migration has been overestimated), Prof. Skottsberg enters into a special consideration of the history of the Juan Fernandez flora, and discusses the bearing of Wegener's theory on the question of Pacific floras, holding that there is much in favour of a modified form of the theory. His general conclusion is in favour of a continental origin for the Juan Fernandez flora, and he thinks that it existed long before the present islands were formed, and gradually took possession of them during the submergence of their old home. Part was derived from the Antarctic continent by way of South America, thus explaining the affinities with New Zealand or Polynesia. The author believes that the history of the Hawaiian flora will be found similar in principle to that of Juan Fernandez, and that the disappearance of the Tertiary Antarctic flora is of fundamental importance, greatly underrated by plant geographers.

CORRESPONDENCE

Mud Markings at Ruafa

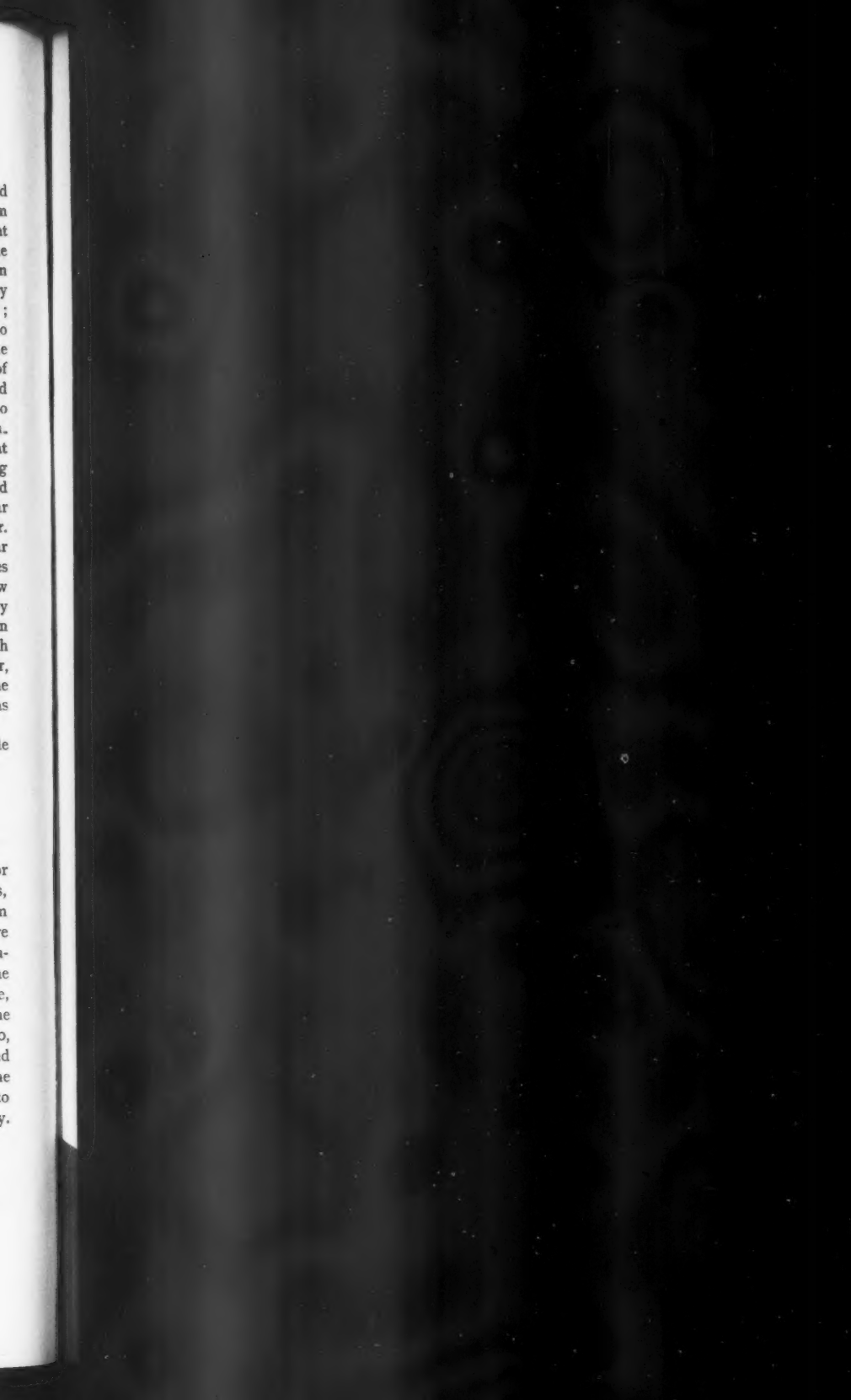
MR. Bowman's circular depressions in a desert clay pan (*Geogr. Journ.*, vol. **68**, August 1926, pp. 147–9) are interesting, as they are probably related to structures widespread in desert-formed rocks. These rocks often include rounded or spherical bodies that look like sandstone concretions. I described one variety ('Rift Valleys and Geology of East Africa,' 1921, p. 51) in which the spherules were so regular and crowded that the rock looked like a spherulitic

trachyte; but closer examination, confirmed by microscopic study, showed that the spherules were composed only of larger grains of the minerals that form the base of the rock. These formations occur in the desert deposits in different lands. Thus, in the Permian Brodick Sandstone of Arran similar sandstone spherules are common. I pointed them out to the Geologists' Association (*Proc. Geol. Assoc.*, **35**, p. 407), as still unexplained structures. As they there contain calcite, they might be regarded as calcareous segregations; but that explanation would not do for the Mariakani Sandstone. They also occur in the Triassic rocks of Grinshill, 7 miles north of Shrewsbury. The cause of the pits remains uncertain. To a geologist in Glasgow, the home of the bubble theory of cone-in-cone structure, that explanation naturally suggested itself; but it appeared inadequate, and the only conclusion that has seemed to me satisfactory is that these bodies represent the filling of pits made by raindrops. I have seen some larger circular depressions of the same type that were due to the wind blowing away young plants, the shallow roots tearing away a cake of mud owing to the existence of a circular shrinkage crack around the plant. That explanation would not apply to Mr. Bowman's regular depressions or to the spherules in the Mariakani Sandstone. I notice that Mr. Beadnell mentions the raindrop idea, but discards it as he interprets the circular structures in Mr. Bowman's photograph as elevations, whereas the text states clearly that they are depressions. [They were mostly depressions, but a few elevations.] As Mr. Bowman's pits range up to 2 inches in diameter, they are too large for ordinary raindrops, but might be due to hail. Mr. Bowman rejects that agency owing to the regularity of the pits, but his photograph shows that they vary greatly in size and in shape; some of them are angular, and were apparently deformed by the pressure of later depressions. The linear arrangement of the pits in part of the slab is as difficult to explain as due to raindrops or hail as to bubbles.

If specimens of the slabs are available microscopic examination might decide between the possibilities. J. W. GREGORY.

THE MEMORIAL TO MUNGO PARK AND RICHARD LANDER

In the *Journal* for January 1925 we called attention to the appeal for donations towards the erection of a memorial to the two West African pioneers, Park and Lander. The Committee then decided that it should take the form of an obelisk, 50 feet high, to be set up on Jebba Island, at the point where the Niger is crossed by the Lagos–Kano railway, an appropriate spot to commemorate the opening up of the interior of West Africa. The design of the memorial, with the bronze tablet to be fixed to it, and photographs of the site, are being shown for a short time in the Museum of the Society's House. The tablet bears the inscription: "To Mungo Park 1795 and Richard Lander 1830, who traced the course of the Niger from near its source to the sea. Both died in Africa for Africa." The Committee still require £100 to complete the work, and would be glad to receive further donations, which should be sent to the Secretary, Park-Lander Memorial Committee, at the House of the Society. Cheques should be crossed "Bank of British West Africa."



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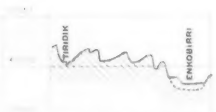

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SECTION BB AT LAT. 1° 11' 30" SOUTH

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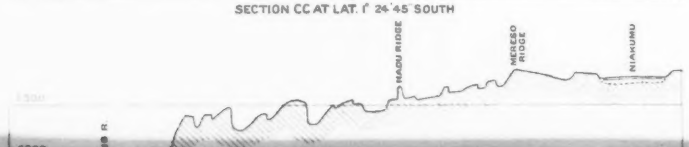
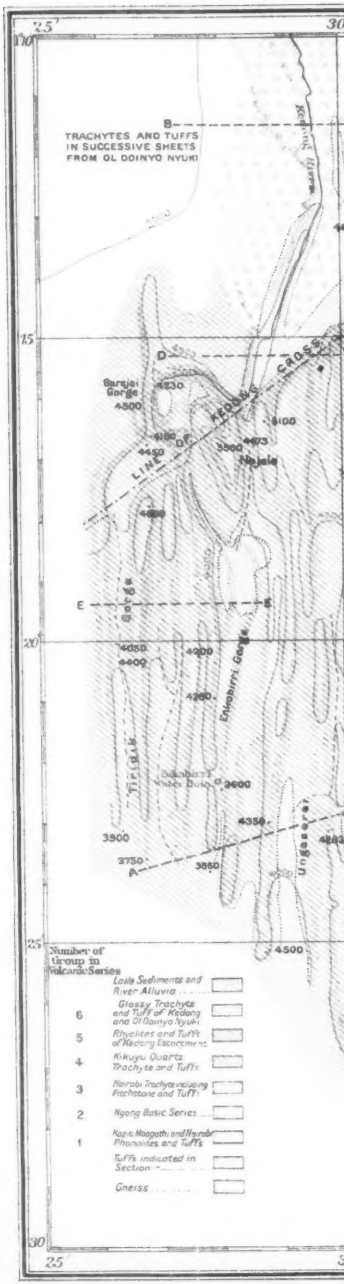
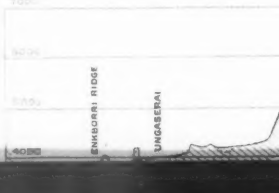



TRACHYTES AND TUFFS IN SUCCESSIVE SHEETS FROM OL DOINYO NYUKI
Banjai Gorge
Kedong Gorge
Njiale
Ebenezer Water Dam
Number of Group in Volcanic Series
Lake Sediments and River Alluvia
Glassy Trachyte and Tuff of Kedong and Ol Doinyo Nyuki
Rhyolites and Tuffs of Kedong Escarpment
Kikuyu Quartz Trachyte and Tuffs
Nairobi Trachyte including Pitchstone and Tuffs
Ngong Basic Series
Kapiti Magadi and Nairobi Phonolites and Tuffs
Tuffs indicated in Section
Gneiss

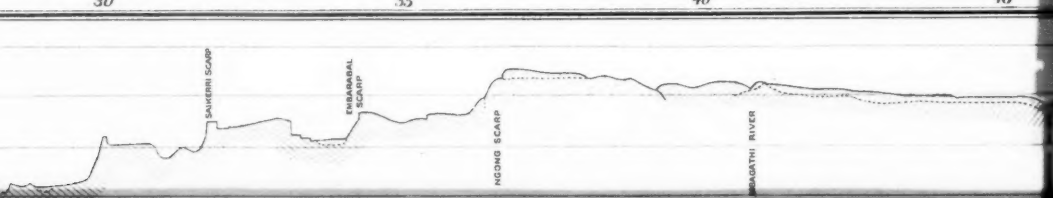


Map to illustrate

THE STRUCTURE OF THE EASTERN FLANK

BY H. L. S

(Director of Public Works

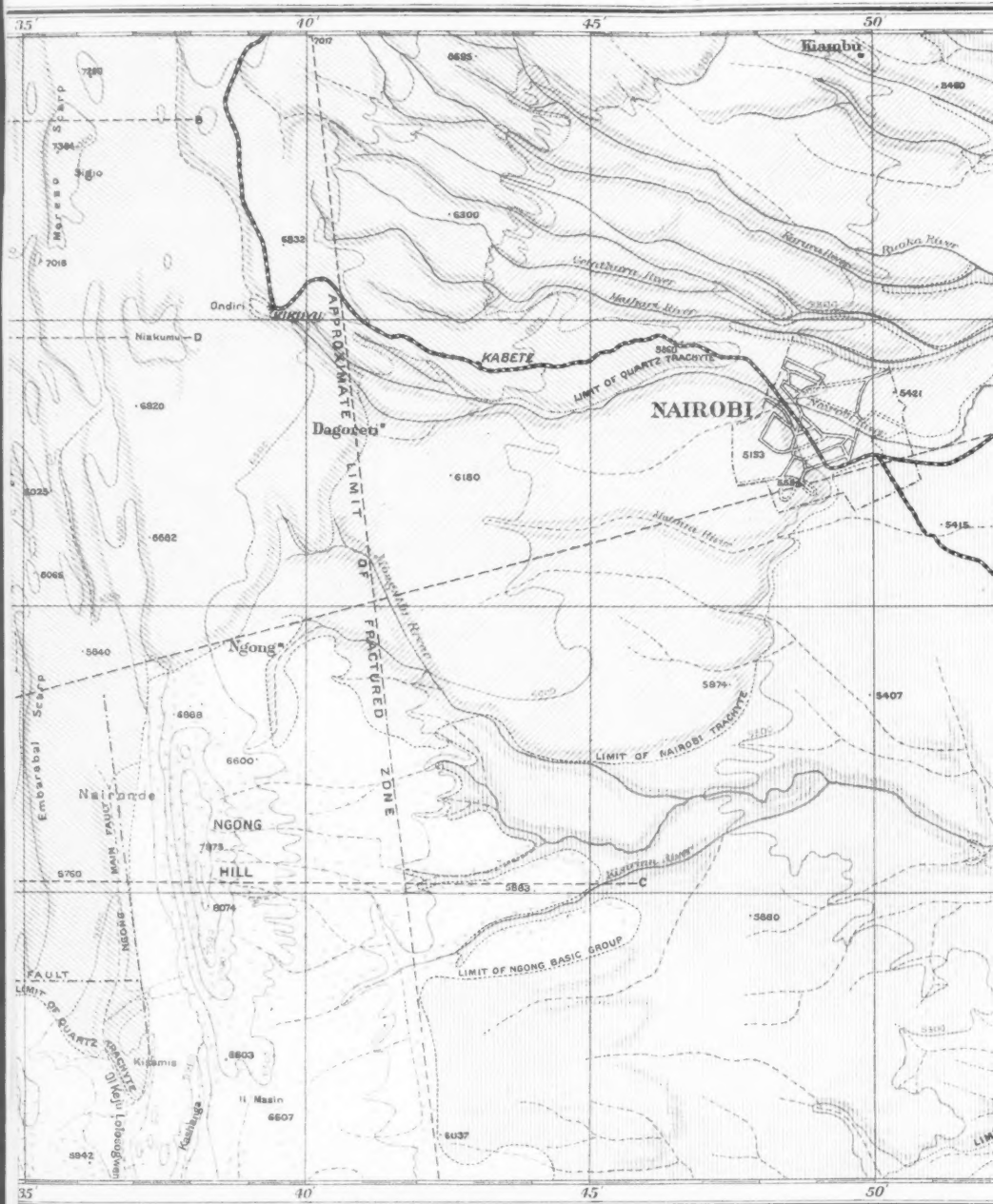


Map to illustrate the paper on

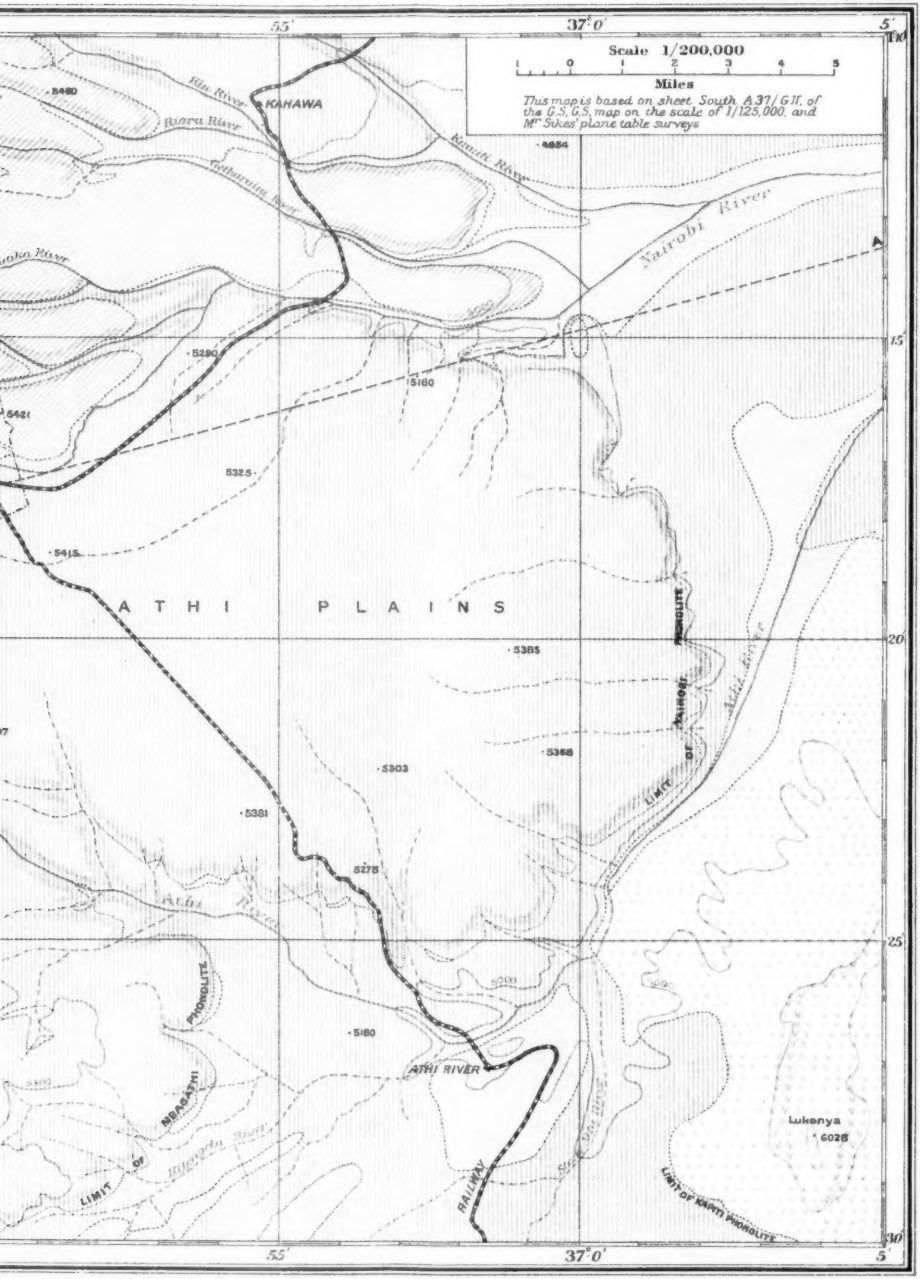
RUCTURE OF THE EASTERN FLANK OF THE RIFT VALL

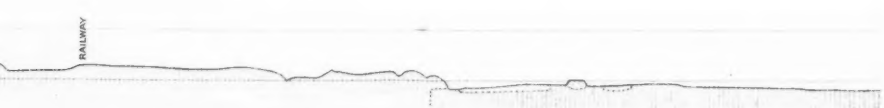
BY H. L. SIKES

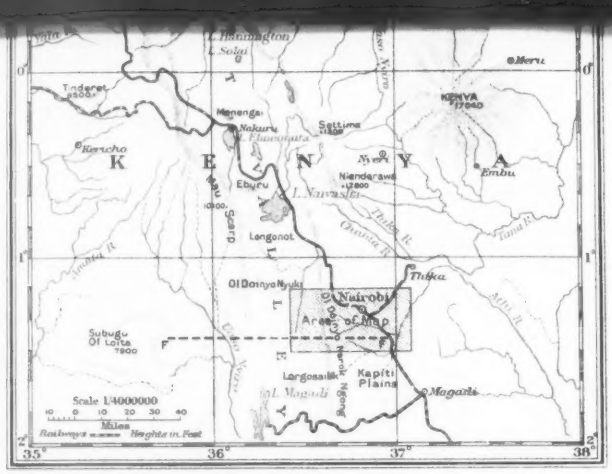
(Director of Public Works, Kenya Colony)

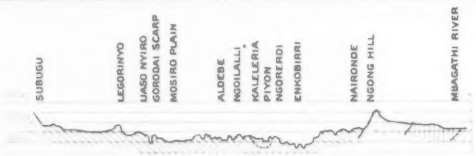


VALLEY NEAR NAIROBI









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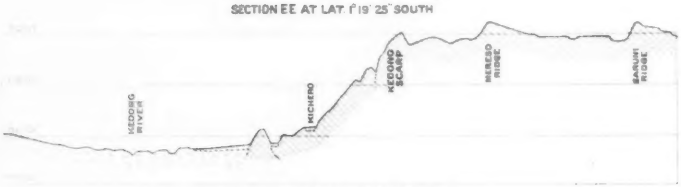

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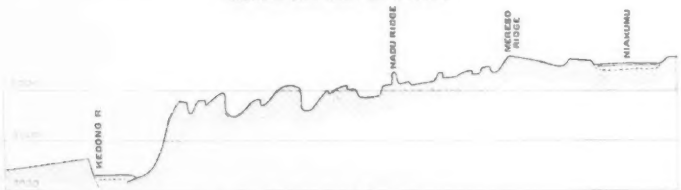

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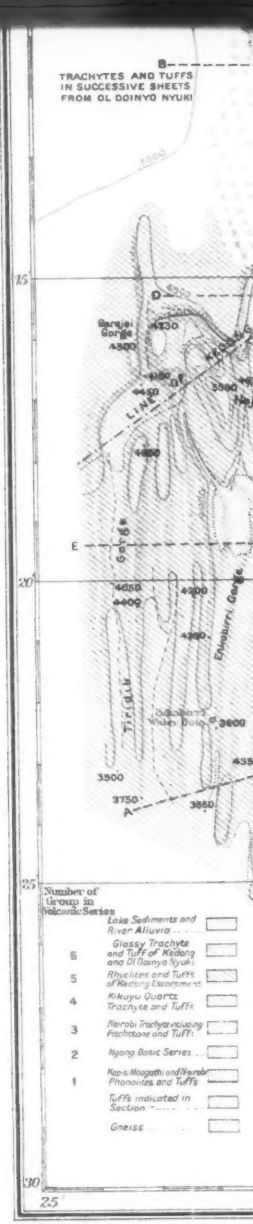

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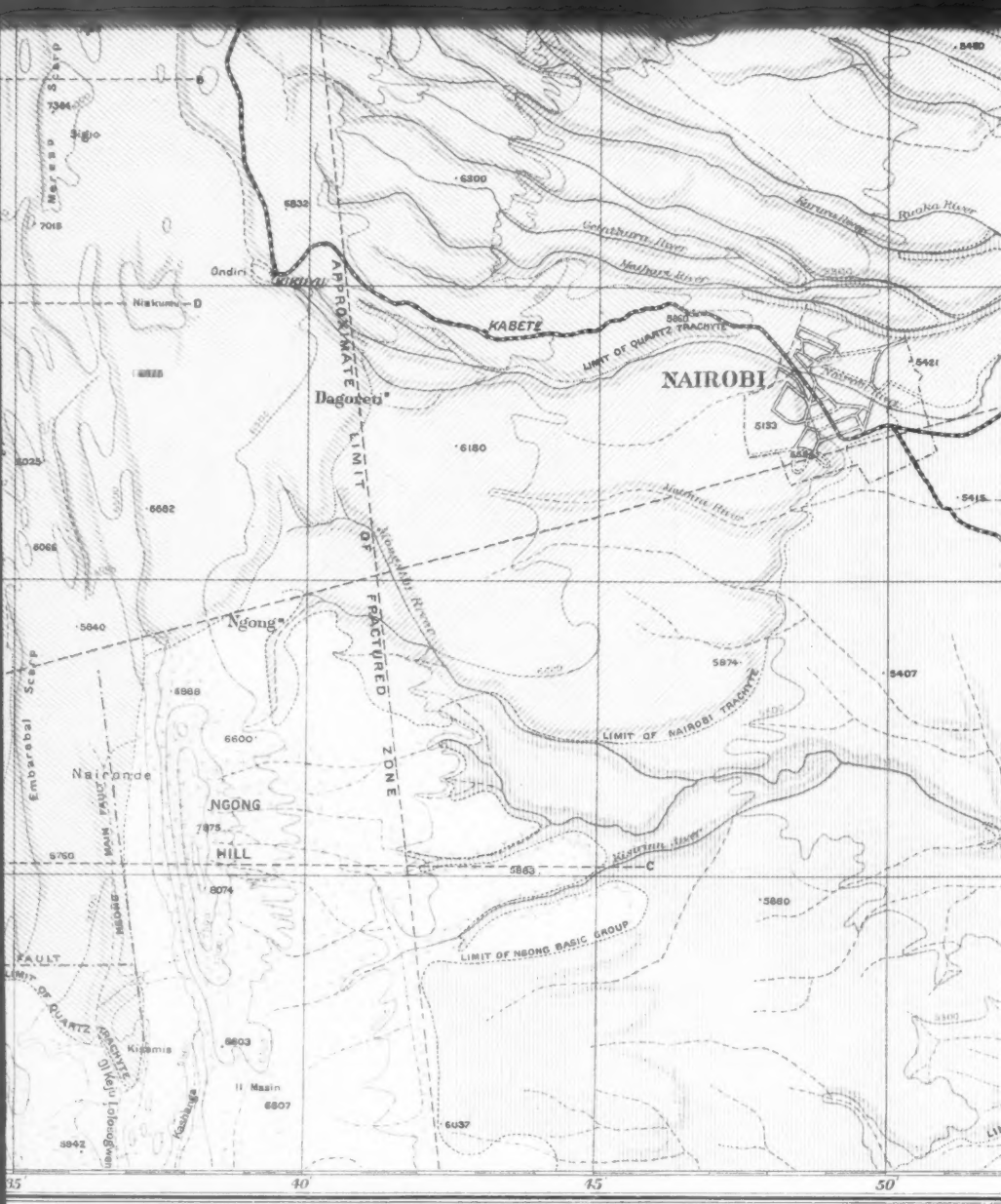

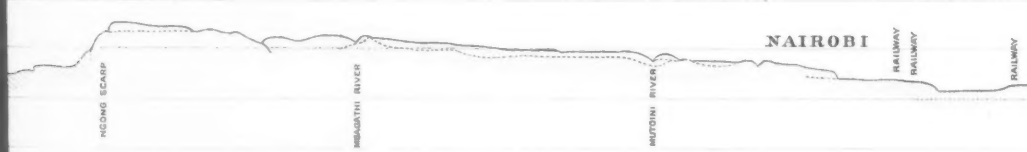

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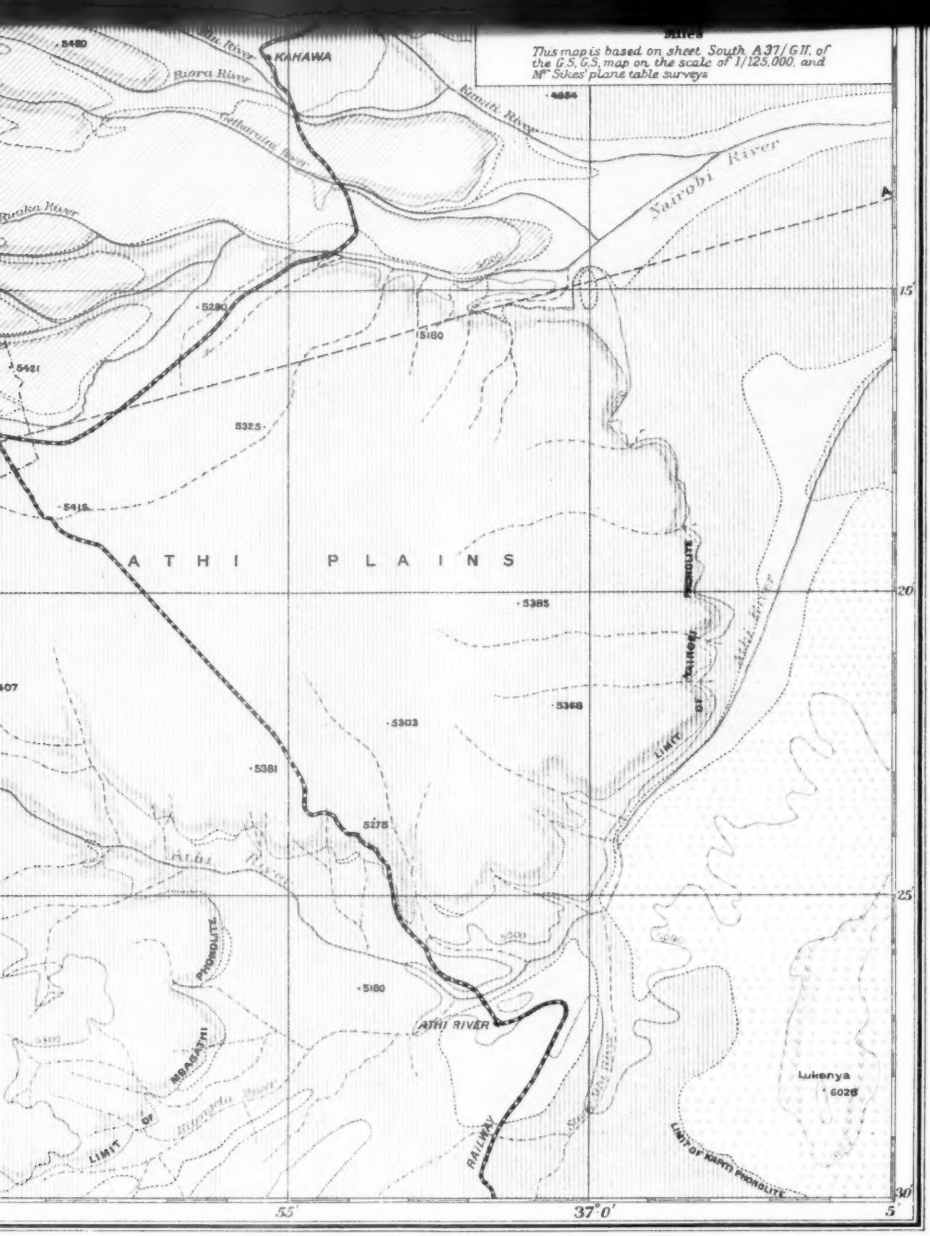

RAILWAY

RIFT VALLEY, NEAR NAIROBI

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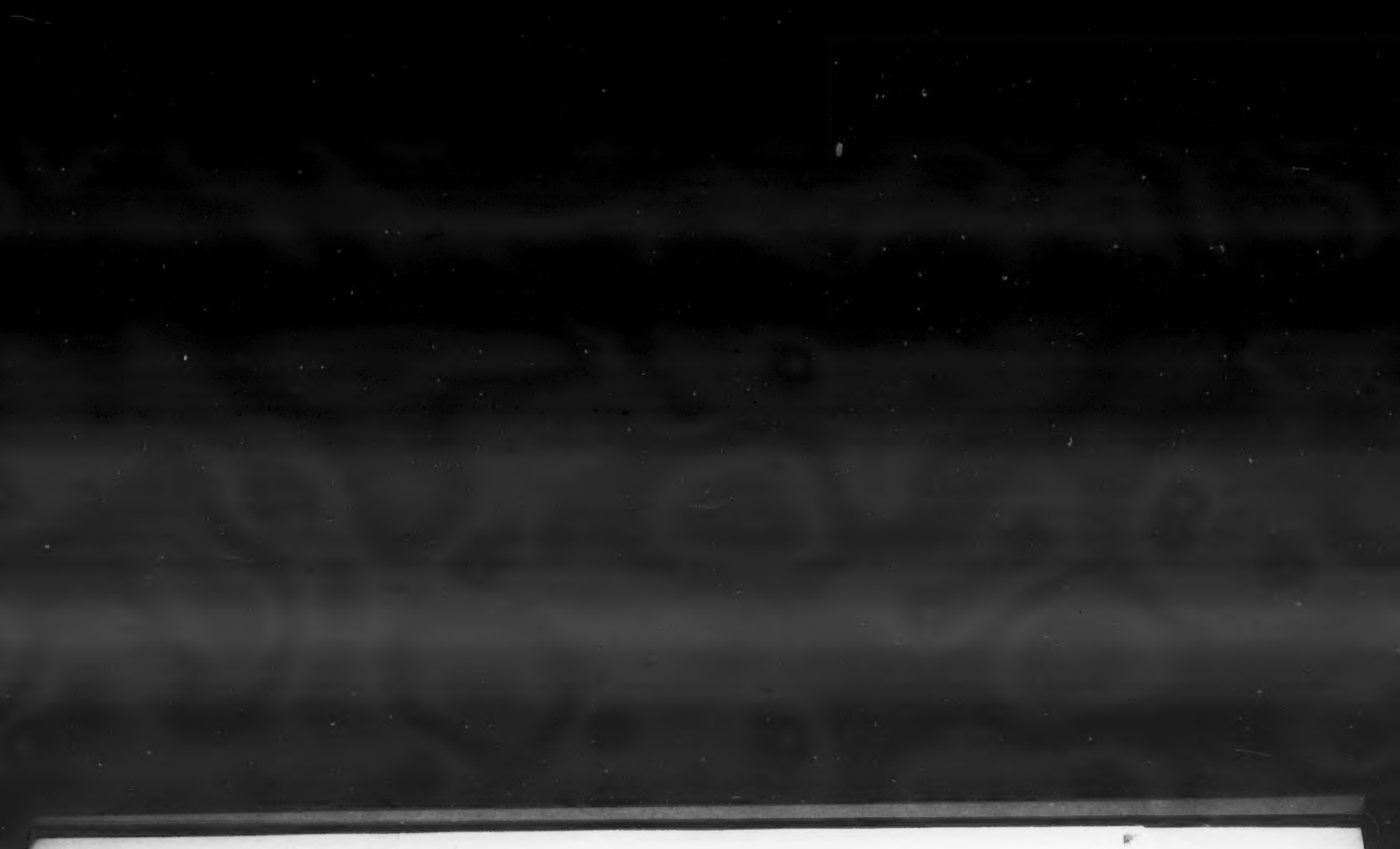
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